OPINIONS OF THE MEDICAL PRESS.

[From the New York Medical Record.]

This volume contains a great deal of information in a convenient and condensed form. Each division is well illustrated, thereby rendering the text doubly clear. Lister's "antiseptic dressings" are well described. The chapter on "Bandaging" is excellent; all the ordinary varieties, as well as Mayor's "handkerchief system," the starch, plaster-of-Paris, silica, and Sayre's suspension apparatus, are described and illustrated. "Ligations" are arranged under special heads for each artery, viz., Surgical Anatomy, Course, Surface Markings, General Relations, Guide, Structures to be Avoided, Operation. The illustrations of this subject are profuse and fairly good. "Amputations" is an equally good chapter. Especially useful are the representations of sections of the various extremities at different points, showing the structure.

[From the St. Louis Clinical Record.]

The author is well known as a most careful and pains-taking teacher and accurate writer. These characteristics are strikingly exemplified in this work. It is a hand-book of real value, short, clear, and concise.

[From the Cincinnati Lancet and Clinic.]

Prof. Mears has written a convenient and useful book for students. We can most cordially endorse it as fulfilling well the promise made in its modest preface.

[From the Michigan Medical News.]

The illustrations are very clear and well executed, and the book replete with practical hints. While there are other works of its kind, there are none which more effectually do what it claims to do.

[From the Maryland Medical Journal.]

Dr. Mears is a practical teacher, and his book is written with a view to instruct and prepare students for the practice of surgery as they must meet with it in professional life. It is handsomely illustrated with over 220 wood-cuts. No work could be better adapted to the purposes for which it is intended.

[From the New York Medical Journal.]

The author has certainly handled well the topics selected, and produced a valuable and useful volume.

PRACTICAL SURGERY:

INCLUDING

SURGICAL DRESSINGS, BANDAGING, LIGATIONS AND AMPUTATIONS.

BY

J. EWING MEARS, M.D.,

DEMONSTRATOR OF SURGERY IN JEFFERSON MEDICAL COLLEGE, PROFESSOR OF ANATOMY AND CLINICAL SURGERY IN PENNSYLVANIA COLLEGE OF DENTAL SURGERY, SURGEON TO ST. MARY'S HOSPITAL, GYNÆCOLOGIST TO JEFFERSON MEDICAL COLLEGE HOSPITAL, ONE OF THE VICE-PRESIDENTS OF THE PATHOLOGICAL SOCIETY OF PHILADELPHIA, FELLOW OF THE COLLEGE OF PHYSICIANS OF PHILADELPHIA, ETC.

WITH
TWO HUNDRED AND TWENTY-SEVEN ILLUSTRATIONS.

PHILADELPHIA:
LINDSAY & BLAKISTON.
1878.

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TO

SAMUEL D. GROSS, M.D., LL.D., D.C.L. Oxon.,

PROFESSOR OF SURGERY IN JEFFERSON MEDICAL COLLEGE,

WHOSE EMINENT SERVICES

AS

AUTHOR, TEACHER, AND PRACTITIONER

HAVE CONFERRED

HONOR UPON HIS COUNTRY, HIS PROFESSION, AND HIMSELF,

This Book

IS GRATEFULLY INSCRIBED

BY

THE AUTHOR.

PREFACE.

THIS book has been written in response to the request of students who have been from time to time under the instruction of the author, and who have expressed a desire for a work which should embrace in a condensed form the subjects herein treated of. It has been the endeavor of the author to present these subjects in as concise a manner as possible, and at the same time to omit nothing which might be deemed necessary to render the instruction complete. While he has aimed to embody chiefly the results of his own experience as a teacher and as a practitioner, he has not hesitated to make use of the standard text-books on surgery, and of such works as are devoted to the consideration of the special topics presented in this.

With a few exceptions, the illustrations are reproductions from the works of GROSS, H. H. SMITH, STEPHEN

SMITH, ASHHURST, PACKARD, MAUNDER, HEATH, BELLAMY, and BERNARD and HUETTE. The anatomical relations of the arteries are largely those which are given in "Gray's Anatomy," the correctness of which has been verified by dissections and operations.

Messrs. Gemrig and Kolbé, instrument-makers, of this city, and Messrs. Stholmann, Pfarre & Co., of New York, have placed the author under obligations for the loan of cuts of instruments.

To Dr. JOHN W. BARR his thanks are especially due for valuable aid in correcting the proof of the work.

PHILADELPHIA, 1429 Walnut St.
October, 1878.

CONTENTS.

PART I.

SURGICAL DRESSINGS.

PART II.

BANDAGING.

PART III.

LIGATIONS.

PART IV.

AMPUTATIONS.

PRACTICAL SURGERY.

PRACTICAL SURGERY may be divided conveniently into two parts: First, that part which relates to the preparation and application of surgical dressings—mechanical; and, second, that which embraces surgical operations—the use of cutting instruments and the production of wounds—operative.

PART I.

SURGICAL DRESSINGS.

UNDER this term may be included all appliances which are employed in the treatment of wounds, made either by the surgeon in performing operations, or those which are caused by injuries.

They consist, in general, of Compresses, Plasters, Poultices, Splints, and Bandages, and are prepared in such manner as to fulfil the indications presented in each individual case.

Compresses are folded pieces of various materials, such as lint, charpie, cotton, wool, oakum, muslin, linen, etc., which are placed upon a part and retained by means of bandages.

Lint is a soft, flocculent substance prepared by scraping the surface of a piece of old linen. That known as patent lint is made by machinery. Recently another form of lint, made from paper and called paper-lint, has been prepared, which possesses remarkable absorbent properties. Lint, rendered antiseptic by boracic acid and other agents, is also found in the shops.

Charpie.—This consists of a mass of loose short threads, made by separating pieces of linen or muslin measuring four or five inches square. It may be either fine or coarse, according to the character of the material employed. It can be arranged into a variety of forms, so as to be adapted to the various kinds of wounds; these are called tents, pledgets, etc.

Cotton.—In the raw state or arranged in sheets, as cotton batting, this material is used as a dressing. In this respect, its value has been increased recently by the introduction of various processes which are employed to render it antiseptic, and give to it absorbent properties. It can be made *hygroscopic* by boiling it in lye. Salicylic cotton is made by immersing the hygroscopic cotton in solutions of salicylic acid, alcohol, and water. Three per cent. salicylic cotton is made by immersing twelve pounds of hygroscopic cotton in a solution of six ounces of salicylic acid, one gallon of alcohol (sp. gr. 0.830), and nine gallons of water, at a temperature of 150°.

Wool.—Finely carded wool has been employed as a dressing; it possesses no advantage over cotton, and is more expensive.

Oakum.—This material is made by untwisting and separating pieces of old tarred rope; it is subsequently cleaned, and forms an excellent dressing; is cheap, readily

obtainable, and possesses decided advantages by virtue of the tar it contains.

Tenax or *Tow.*—A preparation of flax or hemp is also used as a dressing; it is not as available as the oakum.

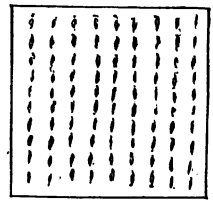
Spongio-piline is made by felting together layers of lamb's wool and sponge, and coating one of the surfaces with rubber, which renders it impermeable to moisture. This is an elegant preparation, but too expensive for general use.

Muslin and *Linen.*—Pieces of old muslin or linen are most frequently used as articles of dressing, and are quite as serviceable as the more costly materials.

The various articles of dressings can be formed into different shapes, as the square, oblong, triangular, cribriform, or graduated compress, the Maltese cross, etc. The formation of the square, oblong, and triangular compress is quite easy, the name indicating the form.

The *Cribriform Compress* is made by folding a square piece of muslin four or five times on itself, and then nicking the border in a number of places with the scissors. When opened, it will present a cribriform appearance. The openings which are made permit the free escape of discharges (Fig. 1).

Fig. 1.



The *Maltese Cross* derives its name from the shape, and is made by folding a square piece of the material from which it is to be formed into an oblong square, folding this into a smaller square, then into a triangle so as to bring the free edges in contact, and

slitting the base of this triangle to two-thirds of its extent, the incision beginning at the end formed by the joining of the free edges (Fig. 2). On opening the piece it will be found that a regular Maltese cross has been formed (Fig. 3).

Fig. 2.

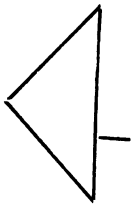
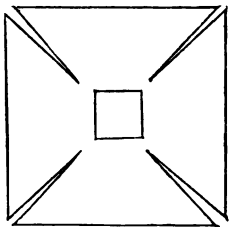


Fig. 3.



The *Half Maltese Cross* is formed by folding an oblong square into a smaller square, then into a triangle, and incising the base as above described (Fig. 4).

These forms are useful in dressing stumps after amputations.

Fig. 4.

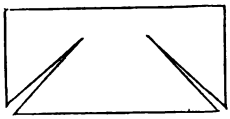
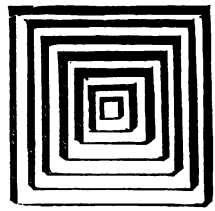


Fig. 5.

The *Graduated Compress* consists of a number of folds, so arranged that each succeeding fold covers about one-half of that preceding it (Fig. 5).

The *Pyramidal Compress* is prepared by sewing together square pieces which gradually decrease in size, so placed as to form a pyramid (Fig. 6). These are used for making pressure.

Fig. 6.



It is frequently desirable to cover dressings with an impermeable covering, so as to retain moisture or prevent the escape of discharges upon the bedclothes or clothing. Among these articles are oiled silk, waxed paper, oiled paper, and gum tissue or rubber cloth.

Oiled Silk is made by coating pieces of silk with layers of boiled oil, containing the oxide of lead to render it dry. This was formerly much employed; lately it has been supplanted largely by less expensive articles.

Waxed Paper.—This can be readily prepared by passing sheets of strong tissue paper through melted white or yellow wax or paraffin, and then hanging them up to dry. It serves the same purpose as the oiled silk, is quite inexpensive, and can be thrown away after being used. A few drops of linseed oil added to the melted wax will render the coating less brittle.

Oiled Paper is made by brushing sheets of paper with boiled oil, which has been reboiled with oxide and acetate of lead, sulphate of zinc, and burnt umber.

Gutta Percha or *Gum Tissue* is a light and elegant dressing, but too expensive for general use.

Rubber Cloth.—This material, prepared in very thin sheets, may be employed as an impermeable covering.

Plasters.—*Adhesive Plaster* (Emplastrum Resinæ). This plaster is found already prepared in the shops, spread upon cotton, twill, or swans' down. Care should be taken to select that which has been recently made; when old it becomes dry, cracks, and loses its attachment to the cloth upon which it has been spread.

In cutting strips, the scissors should be applied with the *blades very slightly open*, using the cutting edges of the points only, and dividing the plaster *lengthwise*, and not *crosswise*. The division should be effected by pushing the scissors along, and not by closing the blades, the piece being firmly held by an assistant (Fig. 7). If cut crosswise, the cloth stretches, and thus interferes with proper application of the strips. The width and length of the strips will vary according to the wants of each case; as a rule, they should be three-quarters of an inch wide, and long enough to extend three inches beyond the edges of the wound. In applying them, they should be placed first in contact with the central and the most dependent part of the wound, in

Fig. 7.

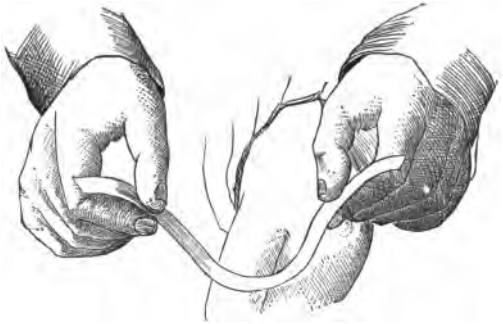
order to draw it up and afford support from below upward. Small triangular pieces may be cut out of the strips at the points of contact with the surface of the wound, so as to permit the discharges to escape. The strips may be made to adapt themselves smoothly and evenly to a round or irregular surface by nicking the edges. Before applying the strips of plaster, it is necessary that they should be heated, and the most efficient, and, at the same time, most convenient method is to place the cloth side of the strips in contact with the surface of a tin can or bottle containing hot water: in this way the surface is equably heated and softened, so as to adhere to the skin. Attempts to heat adhesive strips over the gas-light, candle-light, spirit-lamp, over the surface of the stove, by dipping them in hot water, or by applying such an agent as chloroform, usually result in failures to secure that equable heating and softening of the adhesive surface which is so desirable in securing a firm attachment to the surface of the skin; besides, the strips are liable to be scorched and discolored, and thus detract from the neat appearance of the dressings.

In order to remove the adhesive strips, warm water should be applied to the surface by means of a sponge or cloth. The ends should then be taken hold of, and the strip gently raised from each side of the wound to within an inch of the line of the incision (Fig. 8). The edges of the wound should now be supported by the thumb and index finger of one hand, while the strip is lifted in a vertical direction from the part. Sufficient space should always be left between the strips to permit free escape of the discharges.

Besides the officinal adhesive plaster, other varieties are

employed, such as *Isinglass Plaster*, *Court Plaster*, etc. These require to be moistened, and not heated, in order to

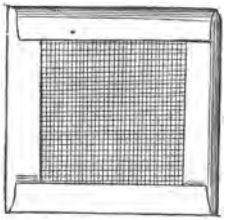
Fig. 8.



be made to adhere to the surface, and are more desirable applications in wounds of the face and head.

Poultices, or **Cataplasms,** are soft, moist substances which are employed in the treatment of wounds (Fig. 9). They are designated as the emollient, astringent, stimulating, fermenting, rubefacient, narcotic, etc.

Fig. 9.



The *Emollient Poultice* is that form most commonly used, and may be made of bread and milk, corn meal and water, flaxseed meal, ground elm bark, or any unirritating substance. The flaxseed or linseed meal poultice is made thus: A quantity of recently ground meal is put into a basin which has

been *scalded*, and *boiling* water is poured into it gradually, the mixture being well stirred, until it acquires a consistency which will prevent its running out when the basin is inverted. It is then to be spread with a spatula or table knife, to a thickness of one-quarter to three-quarters of an inch, upon a piece of strong muslin of the proper size, a border of an inch in width being left uncovered. The corners of the cloth are now incised with the scissors, and the borders folded over so as to form a margin, which will prevent the adhesion of the edges to the surface, and also the escape of the contents of the poultice. A piece of fine white gauze or mosquito netting (that which has been dyed should not be used) may be placed over the poultice to prevent it from adhering, and folded down with the edges of the cloth. A few drops of olive oil may be poured over the surface to soften it, or any article with which it is thought desirable to medicate the poultice, as tincture of opium, etc.

In order to retain the moisture in the poultice, it should be covered with a piece of oiled silk, or with waxed paper.

As a rule, poultices should be renewed twice in twenty-four hours,—more frequently if the conditions of the case demand it.

The *Astringent Poultice* can be made by adding the astringent substance to the linseed meal or bread and milk poultice.

The *Stimulating Poultice* may be made of various substances, as grated boiled carrot, horseradish, garlic, black pepper, brine and corn meal, etc.

The *Fermenting Poultice* is usually made by mixing corn meal with yeast or porter.

The *Rubefacient Poultice* is made by mixing flour of

mustard with water until a proper consistency is obtained. Its strength may be reduced by the addition of flour, in the proportions of one-quarter or one-half. Vinegar should not be used in preparing these poultices, as it destroys their rubefacient properties.

A poultice of great value in the treatment of cases of hospital gangrene may be made of equal parts of powdered animal charcoal and brown sugar.

Poultices may be confined to the part by a few turns of a roller or by broad strips of adhesive plaster. When applied to such a part as the breast, they should be cut in a circular form and the circumference nicked to the extent of an inch or more in order that they may adapt themselves to the surface.

Methods of Irrigation.—It is frequently necessary, in the treatment of surgical affections, to apply water dressings, or heat or cold either in the dry or moist form. The simplest method in the moist form is to apply compresses wrung out in warm or cold water; this is inconvenient, however, and does not secure a uniform effect. A simple and efficient plan is to put a piece of lamp-wick or a number of threads into a reservoir of water placed some distance above the level of the patient's body, which, acting as a siphon, conveys the fluid uniformly over the part.

Dry cold and dry heat may be conveniently applied in the form of the rubber bags or thin metallic boxes—containing in the one case ice, and in the other hot water. The most efficient method of applying dry cold or heat is by means of the rubber tubing as suggested by M. Petitgand. A flexible rubber tube sixteen to twenty feet in

length and one-half of an inch in diameter is applied around the part in a spiral manner and held in position by a few turns of a roller or by adhesive strips. The walls of the tube should be not more than a line in thickness, and the end which is placed in the reservoir should have a metallic cap heavy enough to sink it, and so arranged that the water can have free access to the tube. The other end should be provided with a stopcock and nozzle, so that the flow of the water through the tube can be regulated. The reservoir of water is placed above the level of the patient, as in the other forms. In all cases where water-dressings are employed, the bed should be protected by a rubber cloth or other suitable material.

Sponges.—These play an important part in all surgical operations and in the dressing of wounds. They should be selected with great care, and none but those which are of fine and soft texture should be used. When obtained in the shops, it will be found that, as a rule, they contain particles of sand and sometimes other foreign substances. Before using, therefore, they should be thoroughly beaten, washed, and allowed to soak for a number of hours, if practicable. When the calcareous particles cannot be entirely removed by washing, they should be placed for a short time in a dilute solution of hydrochloric acid, one part to thirty of water, which will dissolve them. It is of great importance that they should be perfectly free from all foreign matter, and should be made *scrupulously clean* before using. It is a good and safe rule to have *new* sponges for each patient, which will be used only for that person. When new sponges cannot be procured, those which have been used can be thoroughly cleansed by soaking them in

a four per cent. solution of permanganate of potassium, then in a twenty-five per cent. solution of sulphurous acid, and finally washing thoroughly in water; or, they may be well washed in a solution of carbolic acid and kept constantly in this solution. Under no circumstances should sponges which have been employed in dressing erysipelatous or gangrenous wounds, or those of a contagious character, be used in dressing the wounds of another patient. If this precaution be neglected, the gravest consequences may ensue in the conveyance of infectious diseases.

In dressing a wound the sponge should never be placed in contact with the granulating surfaces. The water should be allowed to flow upon the surfaces by compressing the sponge raised some distance above. About the edges of the wound and adjacent surfaces the sponge should be applied *gently*, so as to remove discharges.

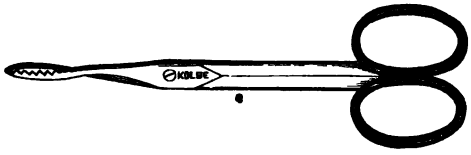
In using the sponges in operations they should be *thoroughly squeezed out* so as to absorb readily the blood, and should be pressed upon the denuded surfaces and not *rubbed*. They should never be used for removing the blood from the floor after operations, or for any purpose other than that for which they were intended.

INSTRUMENTS USED IN DRESSING WOUNDS.

The instruments which are usually required in applying or removing dressings are few in number, and consist of a pair of Dressing Forceps, Dissecting Forceps, and Scissors.

The *Dressing Forceps* are shaped like the ordinary scissors, terminating in rounded, spoon-shaped ends, the edges and inner surfaces of which are serrated. They are used to seize hold of dressings and remove them from the surface of wounds (Fig. 10).

Fig. 10.



The *Dissecting Forceps* are employed to remove minute pieces of dressing, foreign bodies, etc., doing this more readily than the dressing forceps (Fig. 11).

Fig. 11.

The *Scissors* may be either straight or curved, and are used to give shape to the articles of dressings, etc. They

Fig. 12.

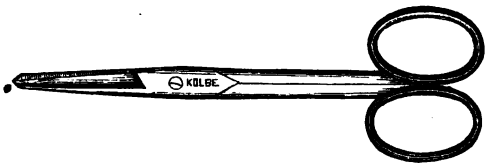
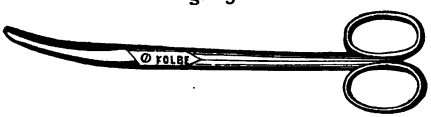


Fig. 13.



should not as a rule be used to divide the tissues, as they produce a contused edge in the wound which interferes with the union (Figs. 12, 13).

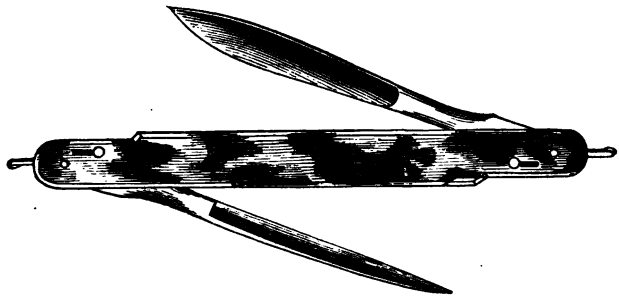
These are found in the Pocket Case, with other instruments which are used in operations and in the treatment of disease (Fig. 14).

Fig. 14.

As it is quite desirable to have the Pocket Case small in size and not too bulky, and yet contain all of the instruments required, some tact has been displayed in arranging them. That known as Professor S. D. Gross's case contains: One Scalpel and Straight Bistoury; two Curved Bistouries,

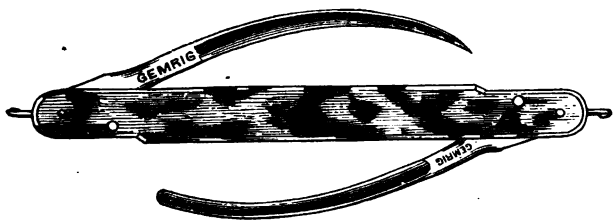
probe and sharp-pointed; one Tenotome and Tenaculum; one pair Artery and Needle Forceps combined; one pair

Fig. 15.



of Scissors; one pair of Polypus and Dressing Forceps; one pair Dissecting Forceps; one Exploring Needle; one male and female Catheter; one Porte-caustique; one

Fig. 16.



Gross's Ear Instrument; one Grooved Director; one pair of Probes; one half-dozen Needles, and one skein of Silk. The cutting instruments are double-bladed, with slide locks to secure the blades, either opened or closed (Figs. 15, 16). Dr. W. W. Keen has suggested a modifi-

cation of the pocket case which materially reduces its size, and at the same time adds three instruments. As arranged by him it measures 4½ × 2½ × 1⅛ inches, and contains in addition a hypodermic needle, a thermometer, and a tubular needle.

DRESSING A WOUND.

In order to dress a wound the following articles and instruments should be at hand: Water, both hot and cold; receptacle for the soiled dressings, basins, sponges, lint or other material to form compresses, syringes, rubber-cloth to protect the bed, towels, bandages, adhesive plaster, tin can containing hot water to heat the plaster, needles, pins, and pocket case containing dressing forceps, dissecting forceps, and scissors.

A sufficient number of assistants should always be present, in order that the dressings may be removed and applied with as little delay as possible. Usually three are required: one to support the part, one to attend to the sponges and supply of water at proper temperature, and a third to hand the dressings and instruments. Before exposing the wound, the assistants should be assigned to their respective positions, the dressings prepared, and everything in readiness. The rubber cloth should be placed so as to protect the bed, and the part lifted by the assistant and held in a comfortable and easy position. The soiled dressings should be removed carefully and placed in a covered receptacle and taken from the room. The wound should be cleansed by allowing the water to flow over it, squeezed out of a sponge held some distance above its margin, or vertically over it. If cavities exist, these can be thoroughly cleansed by throwing water into them with a syringe, being

careful to avoid giving too much force to the stream. The borders of the wound and adjacent surfaces should be gently wiped with the sponge, with *regular and even motions*, carrying it *toward the edges* so as not to cause them to separate or to pull upon the sutures if they still remain. Short, jerking movements should be avoided in using the sponge, as they give pain and are liable to cause separation of the edges of the wound. The sponge should not be placed in contact with the denuded surfaces. Collections of pus can be removed by a gentle stream of water thrown by the syringe, and foreign bodies can be picked off readily by the dissecting forceps.

When cleansed, the borders should be dried by pressing a clean, soft towel upon them, care being taken to avoid bringing it in contact with the wound. If required, the adhesive strips already cut should be applied in the manner directed above (page 19). The compress, upon which has been spread the cerate or substance employed, is placed over the wound, and held in position by turns of the roller or broad adhesive strips.

The more important points in applying dressings, to which the attention of the student is directed, may be expressed in a few general rules:—

I. The position of the patient should be that which is most comfortable and free from restraint. The bed or table should be placed so as to afford ample light and space to those engaged in the dressing.

II. Every article required in the dressing should be prepared and arranged before the wound is exposed. They should be placed in order, so that they can be easily and quickly reached.

III. The removal of the old dressings, the cleansing of

the wound, and the application of the new dressings should all be performed in such manner as to avoid giving unnecessary pain to the patient. Every movement of the surgeon and assistants should be made with care—rough handling of the patient or of the wound should not, under any circumstances, be permitted. If the removal and application of the dressings cause great pain, the patient should be placed under the influence of an anæsthetic agent.

IV. The wound should be exposed for as short a time as possible. Renewal of the dressings, unless the discharge is excessive, is not usually required oftener than once in twenty-four hours. Frequent dressings disturb and expose the wound, and thus interfere with the process of repair.

V. The fingers should not be used in removing the dressings or foreign substances from the wound, lest disease should be thus conveyed from one to another patient, or the surgeon become infected by the discharges.

VI. The hands of the surgeon and assistants should be carefully washed both before and after the dressing.

VII. All of the instruments used should be kept *scrupulously clean.*

THE ANTISEPTIC SYSTEM OF DRESSING WOUNDS.

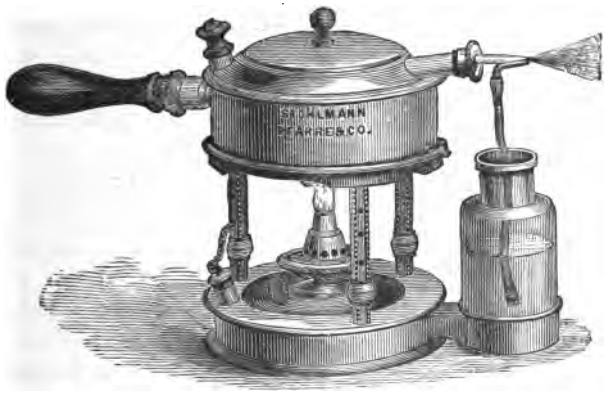
This is a system introduced by Professor Joseph Lister, formerly of Edinburgh, but now residing in London, who defines it as "the dealing with surgical cases in such a way as to prevent the introduction of putrefactive influences into wounds."

The following articles are necessary in order to properly carry out the antiseptic method in surgical operations and dressings:—

1. *Three solutions of carbolic acid*, 1 to 40 (twelve grains to the ounce), 1 to 30 (sixteen grains to the ounce), and 1 to 20 (twenty-four grains to the ounce), should be prepared,—the first for the protective and loose layer of gauze, the second for the spray, and the third in which the sponges, instruments, and drainage tubes are immersed, and also which is used to wash the part and the hands of the surgeon and assistants.

2. *Steam Spray Apparatus.*—This consists essentially of a spirit lamp with a hollow wick, a boiler to contain water, and a spray-tube. An excellent and inexpensive apparatus

Fig. 17.



has been devised by Dr. R. F. Weir, of New York (Fig. 17). In the majority of cases the ordinary steam atomizer can be used with equal facility.

3. *Antiseptic Gauze.*—This is prepared as follows:—Coarse-meshed cotton cloth, known as dairy or cheese cloth, is heated above 212°, and then sprinkled with its

own weight of a mixture of carbolic acid one part, common resin five parts, and paraffin seven parts, the latter being melted together in a water-bath, and the acid then added by stirring. Pressure is then applied, so as to disseminate the liquid equally through the cloth. Old mosquito netting, which has been boiled in lye, can be used in place of the dairy cloth. The gauze is applied over the wound in eight layers. Its purpose is to absorb the fluids from the wound, and to prevent their decomposition.

4. *The Mackintosh.*—This is a material used in the manufacture of hats, and consists of thin cotton cloth with a layer of red vulcanized rubber on one side. Thin rubber cloth, oiled silk, or gutta percha tissue will be found probably as effective. The material used should be free from holes. The Mackintosh is used to compel the secretions to permeate the whole dressing, thus being constantly in contact with the carbolic acid. It is placed between the seventh and eighth layers of the gauze.

5. *Rubber Tubings.*—These are used for drainage, and vary in size from one-eighth to one-half of an inch. Numerous openings, each half the diameter of the tube, are made on the side.

6. The *Protective* is a piece of oiled silk which is placed over the wound to protect it from the irritating effects of the carbolic acid in the antiseptic gauze. It is prepared by coating it with a thin layer of copal varnish, and then brushing over with a mixture of dextrine one part, starch two parts, and sixteen parts of the one-to-twenty carbolic acid solution.

7. *Carbolized Catgut Ligatures* are made by putting catgut ligatures into a mixture of carbolic acid one part, dis-

solved in one-tenth its weight of water, and then added to five parts of olive oil.

8. *Carbolized Silk Sutures* are prepared by placing them in a mixture of melted wax ten parts and carbolic acid one part, and afterward drawing them through a folded cloth to render them smooth.

9. *Sponges.*—These are carefully beaten, cleaned, and washed in lukewarm water, and kept in the one-to-twenty solution of carbolic acid. After use they are cleaned and returned to the solution.

An operation under the system is performed as follows: Three shallow basins (those which are oblong in shape are more convenient) should be at hand; one to hold the instruments and one the sponges, each containing the one-to-twenty-solution. The hands, and particularly the finger ends, of the surgeon and all of the assistants are to be washed in the other basin, containing a solution of the same strength. The bottle of the spray apparatus is filled with the one-to-thirty solution, and the apparatus set in operation. The surface is washed with the one-to-twenty solution, and the spray directed upon the part. The incision is made, the blood cleared away by the sponges, vessels ligated with the catgut ligatures, which are cut off short; drainage tubes introduced into the depths of the wound and brought out to the surface at the most dependent part and cut off short, and the wound closed with the carbolized silk sutures. If complete drainage cannot be effected through the wound, a counter opening should be made, and the drainage tube introduced through it. A piece of the oiled silk protective, of a size to barely cover the edges, is now placed over the wound, then a piece of the gauze, of such size as to largely overlap the

wound, in eight layers, with a piece of mackintosh between the seventh and eighth, and over all a bandage. The protective and six layers of the gauze, with the piece of mackintosh, should be kept in the one-to-forty solution, so as to be wet when applied; the two remaining layers of the gauze are applied dry. If, during the operation, the spray apparatus fails, the piece of gauze must be quickly applied over the wound, and kept there until the spray is again directed upon the part. The dressing is, as a rule, renewed in twenty-four hours, and this is done under the spray, the same precautions being taken as in the first dressing. If the piece of oiled silk protective is unchanged in color, the wound is *aseptic*. If it shows dark brownish spots, which are caused by the action of the liberated sulphur in the pus upon the lead in the oiled silk, the wound is *septic*, and should be washed out with the one-to-twenty solution, or with a solution of chloride of zinc, one part of the solution of the chloride of zinc to three parts of water.

In redressing, everything is renewed except the mackintosh, which can be washed off with the one to-twenty solution and reapplied. The extent of the discharge, the sensations of the patient, and the temperature elevation, are the guides which direct with regard to a renewal of the dressings. If the dressing has been successfully applied, the temperature should be normal or but little elevated. So long as everything is favorable the dressings need not be disturbed: in cases of compound fractures they may be allowed to remain in place for weeks.

In cases of wounds not made by operation, as lacerated wounds, compound fractures, etc., a somewhat different plan of treatment is to be adopted, although the articles of dressing and their method of application are the same.

The wound is to be treated as a septic wound, and is to be thoroughly washed out with a one-to-twenty carbolized solution, or a solution of one part of carbolic acid to five parts of spirits of wine, and then dressed as before described. In cases of suppurating wounds, old ulcers, etc., they should be first swabbed out with a solution of chloride of zinc, forty grains to the ounce, and then dressed with the usual antiseptic dressings.

While it is hoped that pus will not form under the antiseptic method of dressings, yet it is not claimed that it will not occur. In such cases the "antiseptic suppuration," as it is called, is said to be "due to the direct chemical stimulus of the antiseptic."

Splints.— *Splints* are appliances used in the treatment of fractures. They can be made of wood, leather, tin, felt, binders' board, or other material, and fashioned so as to fit the part. Before applying, they should always be carefully padded by covering them with layers of cotton batting, and holding this in place by spiral turns of a roller.

PART II.

BANDAGING.

BANDAGING is the art of applying bandages. Bandages are substances which are employed in the treatment of surgical affections, and consist of the *simple* and the *compound* bandages. They may be made from various materials, such as muslin, flannel, etc. For general use the material best adapted is unbleached muslin; that which is firm, smooth, soft, and closely woven should be selected.

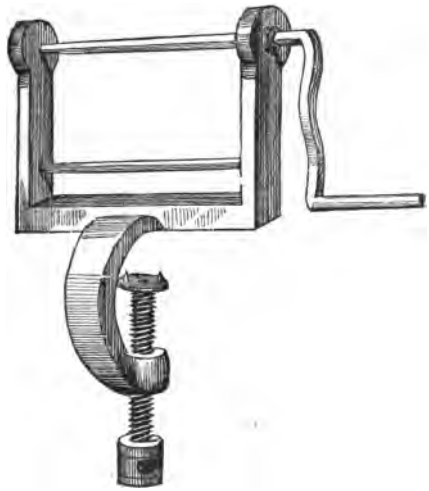
THE SIMPLE BANDAGE OR ROLLER.

This may be from one to four inches in width, and from six to twelve yards in length. The ordinary roller used in practice is six to eight yards long, and two to two and a half inches wide. In preparing the roller a piece of muslin, six to twelve yards in length and one yard in width, should be soaked in water for some time in order to cause shrinkage, then dried, and smoothly ironed. The selvage is removed, the free edge divided by the scissors at the points marking the widths of the bandages, and the strips torn rapidly, so as to avoid too much unravelling.

In order to apply the bandage it should be formed into rollers or cylinders: this can be done by a machine (Fig. 18) or by the hand. It is quite desirable that the student

should learn to roll the bandage firmly by the hand, as the machine is not always convenient, and besides, con-

Fig. 18.



stant handling of the bandage gives him better knowledge and control of it. The strips can be conveniently made into rollers in the following manner: Having arranged a strip in regular folds, a graduated compress is formed at one extremity and turned over firmly upon the thigh and rolled a few times until a cylinder is formed of such size as to be readily grasped by the hand; then it is placed between the thumb and index and middle fingers of the left hand, the body of the bandage being held by the thumb and extended index finger of the right hand, while the remaining fingers grasp the cylinder. The cylinder thus held is made to revolve upon its axis by the left

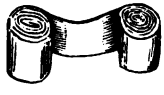
Fig. 19.

hand, while the right revolves partially around the roller itself, these movements soon completing its formation. In forming the roller in this manner, the cylinder may be held in either the right or left hand, as is most convenient (Fig. 19). The roller should be firmly and compactly formed, so that the central portion or axis cannot be pushed out readily. Practice will enable the student to accomplish the formation rapidly and firmly. After forming the roller it should be firmly grasped and all loose threads removed, as these interfere with its proper application.

Rollers are of two kinds, *Single-headed* and *Double-headed.* The single-headed roller consists of a body or central part, an initial and a terminal end, and an external and internal surface (Fig. 20). The double-headed roller has the same parts as the single-headed, both ends being formed into rollers (Fig. 21). The dimensions of the roller for the different parts of the body vary.

Fig. 20.

Fig. 21.



For the Head—Five yards long and two inches wide.

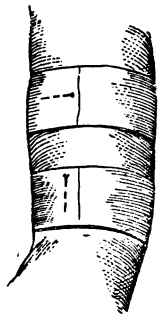
For the Body—Twelve yards long and four inches wide.

For the Extremities—Eight yards long and two to three inches wide.

For the Hand—From five to eight yards long and one inch wide.

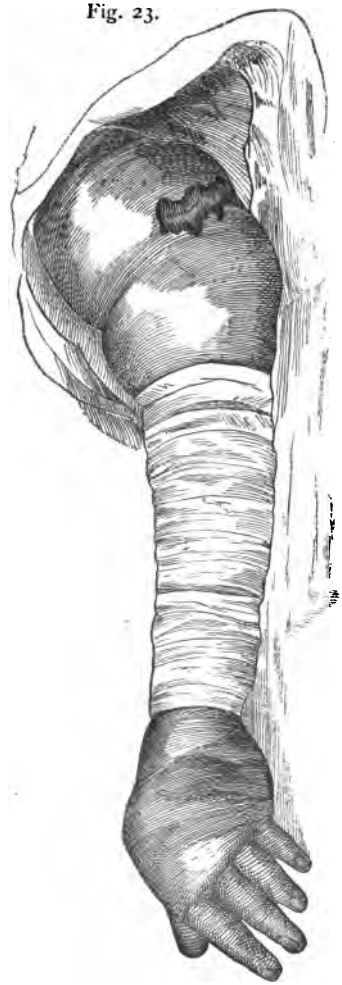
The application of the roller should begin by placing the external surface of the initial end in contact with the part, securing it in position by a circular turn, and the cylinder should be held firmly in the palm of the hand. When the applica-

Fig. 22.



tion is completed, the terminal end should be fastened by folding in the edge and introducing a pin transversely or horizontally as may be most convenient, the head being directed upward or out-

Fig. 23.



Gangrene from tight bandaging.

ward (Fig. 22), care being taken to cover the point. Pins should be introduced at the points where turns of a roller cross one another, so as to hold them in place. In applying a bandage to an extremity, it should begin at the distal part, in order to make equable pressure upon the blood-vessels.

If a wet bandage is to be applied, it should be soaked in the lotion before application, otherwise, undue contraction will ensue if made wet when it is on the limb.

The amount of traction to be used in the application of a bandage is a matter of the utmost importance, and should be very carefully considered by the student; practice alone will enable him to acquire a proper knowledge upon this point. A bandage too tightly applied may do great harm, even to the production of gangrene (Fig. 23), the loss of a limb, and possibly the loss of life. The sensations of the patient and the condition of the circulation in the limb, as shown at the distal points, are the best guides. These should be carefully noted a short time after the application of the bandage. If the patient complains of pain and numbness in the limb, and if the temperature of the part is lowered and the skin gives evidence of retarded circulation, then the bandage should be immediately removed. With regard to the tension the patient should always be consulted, and inspections at short intervals should be made.

In applying the bandage to the head or trunk, the student should stand at the *side* of the patient, not in front of or behind, and in making the various turns of the roller he should not *walk around* the patient but maintain a *fixed position*. In conveying the turns about the part, the bandage should be unrolled with an even and steady movement, not by short jerks. In removing the bandage

from a part, each turn should be carefully taken off and folded in the hand.

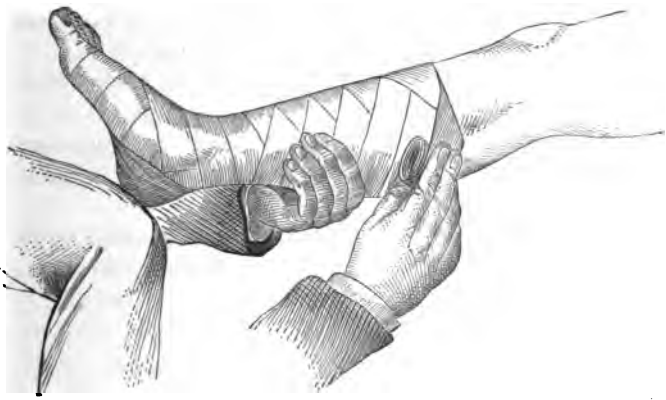
Bandages are designated as the CIRCULAR, OBLIQUE, SPIRAL, SPIRAL-REVERSE, FIGURE-OF-8, SPICA, and RECURRENT, according to the direction they take in application.

The *Circular* bandage consists of circular turns about the part.

The *Oblique* bandage covers the part by very oblique turns.

The *Spiral* bandage is applied by making spiral turns, each succeeding turn covering one-half of the preceding.

Fig. 24.



The reverse turn in this bandage is made in order that the bandage may adapt itself equably and with more firmness to the part. In making it, the limb should be grasped by the left hand, so as to retain the preceding turn by the thumb and fingers; the roller, with not more

than three inches unrolled, should be held above the part, the hand being in a state of supination. The unrolled portion of the bandage being kept perfectly lax, the right hand, holding the roller, should be turned from supination into pronation (Fig. 24), making in this movement a *short* turn, and passing the roller under the limb into the left hand. The position of the roller in the hand should not be changed, nor should traction be made until the limb is passed.

The reverse turns will be in a line, if care is taken to keep the spaces between the successive turns of the bandage equidistant; they should not be made over a joint or a subcutaneous bone, owing to the increased pressure they exert.

In the *Figure-of-8* bandage the turns cross each other so as to resemble the figure after which it is named.

The *Spica* bandage is so named from its resemblance to the arrangement of the leaves of an ear of corn.

The *Recurrent Bandage.*—In this the turns return successively to the point of origin, so as to form a covering for a part.

The simple bandage consists of the Roller, either single or double headed, and is applied to various parts of the body.

BANDAGES OF THE HEAD.

Length of roller five yards, width two inches.

1. Circular bandage of the forehead.
2. Circular bandage of the eyes.
3. Crossed bandage of one or both eyes.
4. Crossed bandage of the angle of the jaw.

5. Knotted bandage of the head.

6. Recurrent bandage of the head, with single or double-headed roller.

7. Gibson's bandage for the body of the lower jaw.

8. Rhea Barton's bandage for the body of the lower jaw.

1. Circular Bandage of the Forehead.

Origin—Side of the head.

Course—Three or four turns encircling the vault of the cranium.

Termination—Side of the head opposite to the point of origin.

Use—To make pressure or retain dressings to the head.

2. Circular Bandage of the Eyes.

Origin—Temporal region.

Course—Three or four turns over the eyes and around the head.

Termination—Temporal region, opposite to the point of origin.

Use—To retain dressings to the eyes.

3. Crossed Bandage of the Eyes.

Origin—Side of the head.

Course—Two circular turns around the head, in a direction from right to left to cover the right eye, from left to right to cover the left eye, thence to the nape of the neck, adapting the bandage to the surface by a reverse turn, if necessary, under the ear, over the eye, across the root of the nose to the side of the head, on a level with the parietal eminence, then circular turn around the head, making two or three turns in this manner alternately, and covering two-thirds of each preceding turn.

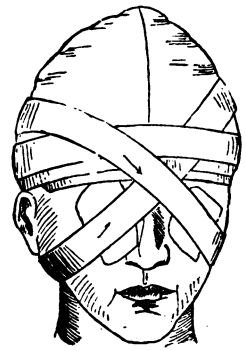
Termination—Circular turn around the head.

Use—To retain dressings to the eye (Fig. 25).

To cover in both eyes, after the first turn over the eye has been made, the bandage should pass around the head and then down across the forehead, the root of the nose, over the other eye, under the ear, to the occiput and side

Fig. 25.

Fig. 26.



of the head, thence around the head to the nape of the neck, and pass in the same direction as in the first turn. Applying these turns alternately, both eyes will be covered.

Use—To retain dressings to both eyes (Fig. 26).

4. Crossed Bandage of the Angle of the Jaw. Roller and compress.

Origin—Side of the head.

Course—Two circular turns around the head, in a direction from right to left to cover *left* angle, and left to right to cover *right* angle, to the nape of the neck, making a reverse turn, if necessary, behind the ear, under the jaw,

over the angle of the jaw, up in front of the ear, over the vertex obliquely, down *behind* the ear of the side opposite, under the jaw and repeat the turns three times, advancing from the angle of the jaw to the corner of the mouth.

Termination—By a reverse turn on the side of the head opposite to the injured side, and making two circular turns from before backward around the head.

Use—To support parts in the treatment of fracture of the angle of the jaw.

5. Knotted Bandage of the Head. Double-headed roller and compress.

Origin—Body of the bandage over the compress covering the wound in the artery.

Course—Carry both heads of the roller around the head in opposite directions, passing at the temporal region of the opposite side and returning to point of origin. Change the direction by making a half turn or twist over the compress, carrying the heads of the roller in opposite directions over the vertex and under the chin to the temple of the opposite side, passing and returning to point of origin, where a second turn or twist should be made and the heads of the roller conducted as in first turn, placing the knots behind each other in order. Continue these turns until three or four knots are formed.

Termination—Circular turns around the head, covering the knots.

Use—To make compression in wound of the temporal artery (Fig. 27).

NOTE.—This bandage, being applied with great firmness, makes great pressure upon the parts, and should be watched carefully in order to prevent injury.

6. Recurrent Bandage of the Head. Single-headed roller.

Origin—Side of the head.

Course—Two circular turns around the head to the middle of the forehead, then reversing the bandage and

Fig. 27.

Fig. 28.

carrying it from before backward to the middle of the occiput, making a reverse turn and returning to the forehead, covering one-half of the preceding turn and continuing recurrent turns on alternate sides, covering one-half of each preceding turn, until the vertex is covered.

Termination—By a reverse turn and then circular turns around the head to secure recurrent turns (Fig. 28).

Recurrent Bandage of the Head. Double-headed roller.

Origin—Body of the bandage over the middle of the forehead.

Course—The heads of the roller are to be carried in opposite directions around the vertex to the occiput, passing and returning to the point of origin; the recurrent turns are to be made by the head of the roller held in the right hand, each turn being secured by circular turns made

Fig. 29.

by the head of the roller held in the left hand (Fig. 29); continue these turns until the vertex is covered.

Termination—Circular turn around the head.

Use—Both bandages are used to retain dressings to the head.

7. Gibson's Bandage for the Body of the Lower Jaw.

Origin—Temporal region.

Course—Down in front of the ear, under the chin, up in front of the ear of opposite side, over the middle of the vertex to the point of origin, making two turns; then re-

verse the bandage from *before backward*, making two circular turns around the head to the point of origin; thence to the nape of the neck, making reverse turn if necessary, carrying under the ear, in front of the chin, and back to nape of the neck. Repeat this turn, make a reverse turn and go to side of the head, and around the head by two turns to the middle of the occiput; make a reverse turn and carry bandage over the vertex to forehead (Fig. 30).

Termination—Either by circular turns around the head or by turn from occiput to forehead.

Use—To support parts in treatment of fracture of the body of the lower jaw.

Fig. 30.

Fig. 31.

8. Rhea Barton's Bandage.

Origin—Beneath the occipital protuberance.

Course—Obliquely upward over the parietal eminence, across the junction of the sagittal and coronal sutures, down in front of the ear, under the chin, up in front of

the ear of the opposite side, across the junction of the sagittal and coronal sutures, over the parietal eminence to the point of origin; thence obliquely downward and forward over the angle of the jaw, in front of the chin, over the angle of the jaw of the opposite side, obliquely upward and backward to the point of origin. Continue these turns until the bandage is exhausted (Fig. 31).

Termination—Occipital region.

Use—To support the parts in treatment of fracture of the body of the lower jaw.

BANDAGES OF THE TRUNK.

1. Circular bandage of the neck.
2. Figure-of-8 bandage of the neck and axilla.
3. Anterior figure-of-8 bandage of the chest.
4. Posterior figure-of-8 bandage of the chest.
5. Crossed bandage of one or both breasts.
6. Spica bandage of the shoulder.
7. Spiral bandage of the chest.
8. Circular bandage of the abdomen.
9. Spiral bandage of the abdomen.
10. Spica bandage of one or both groins.

1. Circular Bandage of the Neck. Length of roller, two yards; width, two inches.

Origin—Side of the neck.

Course—Three or four circular turns around the neck.

Termination—Side of the neck.

Use—To retain dressings to the neck.

2. Figure-of-8 Bandage of the Neck and Axilla. Length of roller, five yards; width, two inches.

Origin—Side of the neck.

Course—Two circular turns around the neck; thence over the point of the shoulder, backward and downward to the axilla, under the axilla, up in front over the shoulder to the point of origin, repeating these turns two or three times.

Termination—Circular turn around the neck.

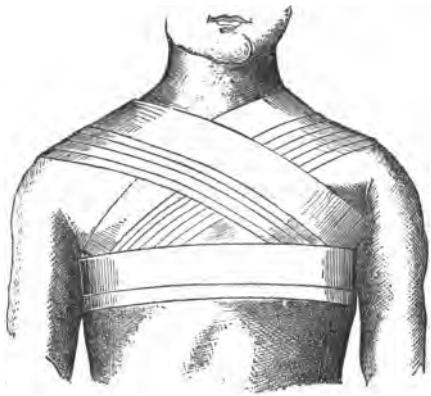
Use—To retain dressings over the shoulder or in the axilla.

3. Anterior Figure-of-8 Bandage of the Chest. Length of roller, seven yards; width, two and one-half inches.

Origin—Axilla of either side.

Course—Two circular turns around the chest to the point of origin, thence obliquely upward across the chest to the point of the shoulder, over the shoulder backward and

Fig. 32.



downward to the border of the axilla, under the axilla obliquely upward, across the chest to the opposite shoul-

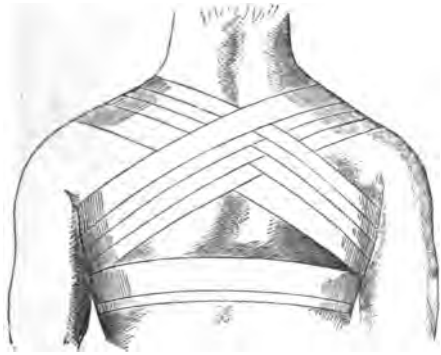
der, over the shoulder, backward and downward to the border of the axilla, under the axilla, repeating these turns three or four times (Fig. 32).

Termination—By circular turns around the chest.

Use—To draw the shoulder forward, and to retain dressings on the anterior surface of the chest.

4. Posterior Figure-of-8 Bandage of the Chest. This bandage is applied in the same manner as that just described, the turns being carried over the posterior instead of the anterior surface of the chest (Fig. 33).

Fig. 33.



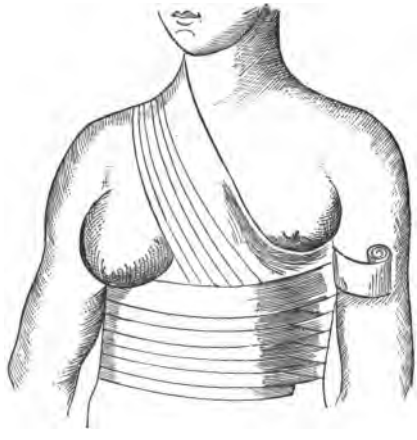
Use—To draw the shoulders back in the treatment of fracture of the clavicle, or to retain dressings on the posterior surface of the chest.

5. Crossed Bandage of one or both Breasts. Length of roller, eight yards; width, two and one-half inches.

Origin—Axilla of the affected side.

Course—Two circular turns under the breasts, around the chest to the point of origin, thence obliquely upward under the affected breast, across the front of the chest to the shoulder, over the shoulder, obliquely downward across the back of the chest to the point of origin; then by a circular turn, under the breast, around the chest to the

Fig. 34.



point of origin; continue these turns alternately, gradually advancing forward in the oblique turns, and upward in the circular turns until the breast is fully supported (Fig. 34).

Termination—Circular turns around the chest.

Bandage for both Breasts. Length of roller, twelve yards; width, two and one-half inches.

This bandage is applied in the same manner as that just described, with the addition of oblique turns, supporting the other breast, which begin when the bandage, in the

second circular turn, the first oblique turn having been made, has reached the opposite axilla; then pass across the back of the chest over the shoulder down obliquely across the front of the chest under the breast to the point of origin. These turns are continued, the circular and oblique turns alternating, until both breasts are supported (Fig. 35).

Fig. 35.

Use—These bandages are used to support the breasts in excessive lactation, or in abscess.

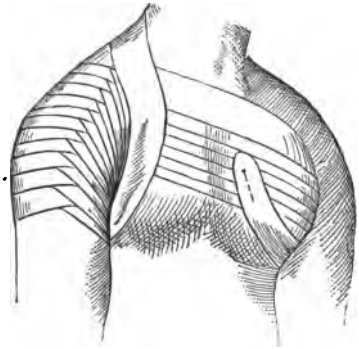
6. Spica Bandage of the Shoulder. Length of roller, eight yards; width, two and one-half inches.

Origin—Arm of the injured side.

Course—Circular and spiral-reverse turns to the point of the shoulder, over the shoulder, obliquely downward across the front of the chest, for the right shoulder, and the back of the chest for the left shoulder, to the axilla of

the sound side, under the axilla, obliquely upward across the front or back of the chest to the point of the shoulder, down in front or behind to the border of the axilla, under the axilla to the point of the shoulder, covering one-half of the preceding turn, thence to the axilla of the sound side. Continue these turns, covering one-half of each preceding turn, until the shoulder is covered (Fig. 36).

Fig. 36.



Termination—Circular turns around the chest.

Use—To retain the head of the humerus in place after dislocation has been reduced.

7. **Spiral Bandage of the Chest.** Length of the roller, ten yards; width, three to four inches.

Origin—Circular turns around the waist.

Course—By spiral turns around the chest, ascending to the axilla, covering one-half of each preceding turn.

Termination—Circular turns around the upper part of the chest.

Use—To make compression in fracture of the sternum or ribs, and to retain dressings.

8. Circular Bandage of the Abdomen. Length of the bandage, from one and a half to two yards; width, from ten to twelve inches.

Origin—Over the crest of the ilium.

Course—Circular turn around the abdomen.

Termination—Over the crest of the ilium.

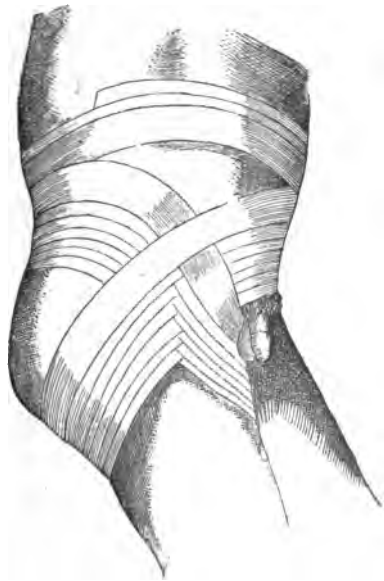
Use—To support the abdominal walls.

9. Spiral Bandage of the Abdomen. Length of the roller, ten to twelve yards; width, three to four inches.

Origin—Around the waist, or over the crest of the ilium.

Course—Spiral turns from above downward, or from below upward.

Fig. 37.



Termination—By circular turns around the pelvis or around the waist, according to the course taken.

Use—To make compression of the abdomen.

10. Spica Bandage of one or both Groins. Length of roller, eight to ten yards; width, two and a half to three inches.

Origin—Above the crest of the right ilium.

Course—Two circular turns around the body above the crests of the ilia, thence obliquely downward across the groin to the inside of the right thigh to cover the right groin, to the outside of the left thigh to cover the left groin, around the thigh, across the groin obliquely upward to above the crest of the left ilium, and then to point of origin; repeat these turns, and cover one-half of each preceding turn, until the groin is covered (Fig. 37).

Termination—Circular turns above the crest of the ilia.

Use—To make compression over the groin, as in case of bubo, or to retain dressings. To cover both groins, the turns, as described above, should be made to alternate (Fig. 38).

BANDAGES OF THE EXTREMITIES.

SUPERIOR EXTREMITY.

Bandages of the Hand.

1. Spiral bandage of the finger.
2. Spiral bandage of all of the fingers, or the gauntlet.
3. Spiral bandage of the palm, or demi-gauntlet.
4. Spica of the thumb.

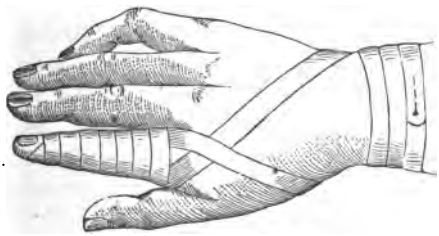
1. Spiral Bandage of the Finger. Length of roller, one yard; width, one inch.

Fig. 38.

Origin—Circular turns around the wrist.

Course—From the wrist across the back of the hand to the base of the finger, thence by very oblique turns to the point of the finger, returning to the base by spiral or spiral-reverse turns, and thence to wrist (Fig. 39).

Fig. 39.



Termination—Circular turns around the wrist.

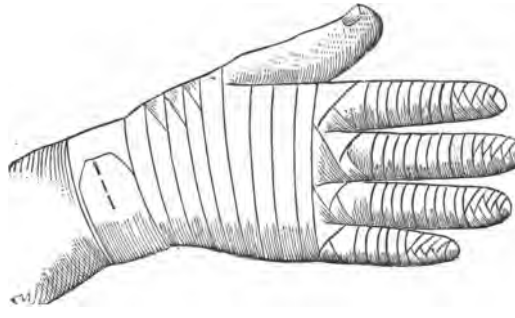
Use—To retain dressings or to support parts in fracture.

2. Spiral Bandage of all of the Fingers, or the Gauntlet. Length of roller, eight yards; width, one inch.

Origin—Around the wrist.

Course—By turns, taking the same direction as those in the preceding bandage, each finger being covered separately, and the palm covered by spiral turns ascending to the wrist (Fig. 40).

Fig. 40.



Termination—Circular turns around the wrist.

Use—To cover all of the fingers.

3. Spiral Bandage of the Palm, or Demi-Gauntlet. Length of roller, six yards; width, one inch.

Origin—Around the wrist.

Course—By circular turns around the wrist, thence downward across the back of the hand to the first interdigital space around the base of the finger, across the back of the hand to the wrist. Repeat these turns around

the base of each finger until the back of the hand is covered.

Termination—Circular turns around the wrist.

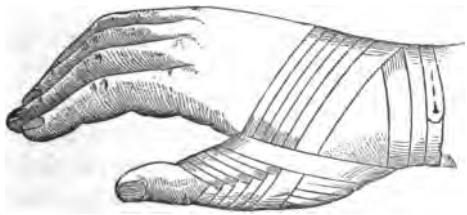
Use—To retain dressings on the back of the hand.

4. Spica Bandage of the Thumb. Length of roller, three yards; width, one inch.

Origin—Around the wrist.

Course—From the wrist across the base of the thumb to the phalangeal articulation, around the thumb, across the base of the thumb to the wrist, and continue these turns, covering one-half of each preceding turn, until the thumb is covered (Fig. 41).

Fig. 41.



Termination—Around the wrist.

Use—To make pressure over the base of the thumb, or to confine dressings.

Bandages of the Arm.

1. Circular bandage of the wrist.
2. Figure-of-8 bandage of the wrist.
3. Figure-of-8 bandage of the elbow.
4. Circular bandage of the arm.
5. Oblique bandage of the arm.
6. Spiral-reverse bandage of the arm.

1. Circular Bandage of the Wrist. This bandage consists of two or more circular turns around the wrist. The spiral-reverse bandage of the upper extremity may begin by these turns.

2. Figure-of-8 Bandage of the Wrist. Length of roller, two yards; width, two inches.

Origin—Around the wrist.

Course—Two circular turns around the wrist, over the back of the hand, to the palm of the hand, across the palm, and over the back of the hand to the wrist; make three or four turns, covering one-half of each preceding turn.

Termination—Around the wrist.

Use—To make compression over the joint, or to confine dressings.

3. Figure-of-8 Bandage of the Elbow. Length of roller, two yards; width, two inches.

Origin—Around the upper part of the forearm.

Course—Two circular turns around the upper part of the forearm, then obliquely upward across the front of the elbow to the lower part of the arm, making circular turns around the arm and returning obliquely downward across the front of the elbow to upper part of the forearm; then by ascending spiral turns covering the entire joint.

Termination—Circular turn around the arm.

Use—To make pressure over the elbow joint, or to retain dressings.

4. Circular Bandage of the Forearm or Arm. The application of this bandage consists in making circular turns around any part of the forearm or arm.

Use—To retain dressings or to compress the superficial veins in venesection.

5. Oblique Bandage of the Forearm or Arm. Length of roller, two to three yards; width, two inches.

Origin—Around the hand.

Course—Two circular turns around the hand, thence by very oblique turns up the forearm and arm to the shoulder.

Termination—Circular turns around the upper part of the arm.

Use—To retain dressings.

Fig. 42.

6. Spiral-Reverse Bandage of the Upper Extremity. Length of roller, eight yards; width, two inches.

Origin—Around the wrist by two circular turns.

Course—From the wrist obliquely downward across the back of the hand to the metacarpo-phalangeal articulation, circular turn around this articulation, thence obliquely upward across the back of the hand to the wrist; then figure-of-8 turn of the wrist, spiral turns over the wrist-joint, ascending the forearm by spiral-reverse turns to the elbow, crossing the elbow-joint by figure-of-ε turns and ascending the arm to the shoulder by spiral-reverse turns (Fig. 42).

Termination—Circular turns around the upper part of the arm.

Use—To support the arm in the treatment of fractures, dislocations, etc.

This bandage may begin by circular turns around the hand, over the metacarpo-phalangeal articulations, and then pass to the wrist by figure-of 8 turns. In passing over the wrist and elbow-joints, simple spiral turns should be made; reverse turns increase the pressure and may do harm.

BANDAGES OF THE INFERIOR EXTREMITY.

1. Figure-of-8 bandage of the ankle.
2. Figure-of-8 bandage of the knee.
3. Figure-of-8 bandage of the thighs.
4. Spica bandage of the instep.
5. Spiral-reverse bandage of the lower extremity covering the heel.
6. French spiral bandage.

1. Figure-of-8 Bandage of the Ankle. Length of roller, two yards; width, two inches.

Origin—Around the leg, above the malleoli.

Course—Two circular turns around the leg above the malleoli, thence obliquely downward in front of the ankle to the side of the foot, under the sole of the foot to the opposite side, obliquely upward in front of the ankle to the point of origin, making as many turns as may be required.

Termination—Circular turns above the malleoli.

Use—To cover in the ankle or to retain dressings.

2. Figure-of-8 Bandage of the Knee. Length of roller, two yards; width, two and one-half inches.

Origin—Side of the upper part of the leg.

Course—Two circular turns around the upper part of the leg, thence from side of the leg obliquely upward across the front or back of the knee to the side of the lower part of the thigh, circular turn around the thigh, then from oppo-

site side of the thigh obliquely downward across the front or back of the knee to side of the leg, making the required number of figure-of-8 turns, and covering the joint by ascending spiral turns.

Termination—Circular turns above the knee.

Use—To cover in the knee or to make compression.

3. Figure-of-8 Bandage of the Thighs. Length of roller, five to six yards; width, two and one-half to three inches.

Origin—Above the knees.

Course—Beginning by circular turns above the knees, and making as many figure-of-8 turns as may be required to secure the limbs firmly together.

Termination—Circular turns around the upper part of the thighs.

Use—To fasten the thighs together after operations or injuries.

4. Spica Bandage of the Instep. Length of roller, six to eight yards; width, two inches.

Origin—Around the metatarso-phalangeal articulation.

Course—By two circular turns around the foot, ascending by spiral-reverse turns to the instep, then obliquely downward to the point of the heel, the edge of the bandage projecting slightly below the border of the sole of the heel, around the heel, obliquely upward to the instep, downward to the side of the foot, under the foot to the opposite side of the foot and to the instep; continue these

Fig. 43.

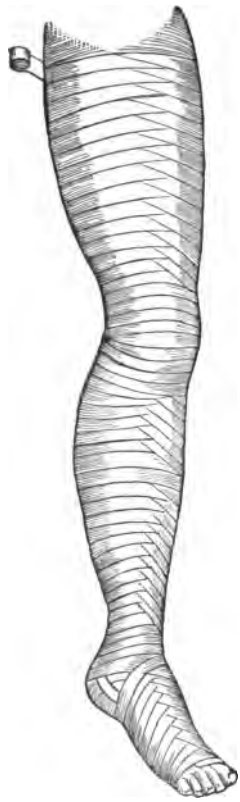
figure-of-8 turns, covering one-half of each preceding turn until the instep is entirely covered (Fig. 43).

Termination—Circular turn above the ankle.

Use—To make firm compression over the instep or ankle.

5. Spiral-reverse Bandage of the Lower Extremity covering the Heel. Length of roller, ten to twelve yards; width, two and one-half inches.

Fig. 44.



Origin—Around the foot at the metatarso-phalangeal articulation.

Course—Two circular turns around the foot, ascending by spiral-reverse turns to high up on the instep, thence over the point of the heel back to the instep, under the sole of the heel, over the side of the heel, around the back of the heel, up to the instep, under the sole of the heel, over the opposite side of the heel, around the back of the heel up to the instep, then figure-of-8 turns of the ankle, spiral turns over the joint, spiral-reverse turns to the knee, figure-of-8 turn of the knee, spiral turns over the joint, and ascending the thigh to the hip by spiral-reverse turns (Fig. 44).

Termination—Circular turns around the upper part of the thigh.

Use—To support the limb after fracture, etc.

This bandage may begin around the ankle and pass to the foot, covering it, and return by figure-of-8 turns to the ankle, and then ascend the limb.

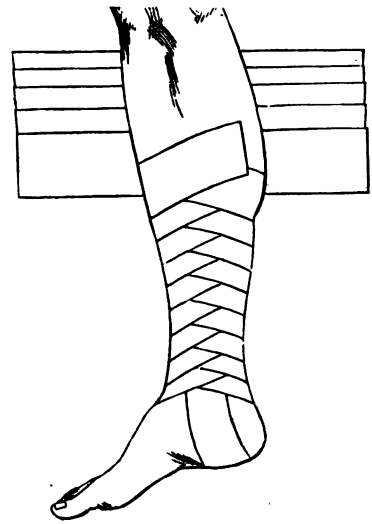
Reverse turns should not be made over the ankle or knee-joints, or over the crest of the tibia, owing to the increased pressure they exert.

6. French Spiral Bandage. This bandage is applied in the same manner as the preceding, the covering of the heel being omitted, passing from the foot to the leg by figure-of 8 turns.

GENERAL BANDAGES.

Bandage of Scultetus. This bandage consists of a number of separate pieces varying in length, the first being sufficiently long to go once and a third around the upper part of the limb, each succeeding piece decreasing one inch. The pieces should be arranged so that each strip covers in one-third of the preceding. The limb is placed upon the strips arranged in order, and the application is commenced at the lowest part, crossing one strip over the other in an oblique direction (Fig. 45).

Fig. 45.



Use—To support the limb in cases of compound fractures, etc., where it is advisable to avoid motion in removing dressings.

Recurrent Bandage for Amputations. Length of roller, four to six yards; width, two to two and one-half inches.

Origin—Three to six inches above the end of the stump.

Course—Two circular turns around the limb to the centre of the under surface, thence by recurrent turns over the extremity of the stump to the centre of the upper surface; continue these recurrent turns on alternate sides of the central turn, covering in one-half of each preceding turn, until the stump is covered. Fix the recurrent turns by spiral turns descending to the end of the stump (Figs. 46, 47).

Fig. 46.

Fig. 47.

Termination—Circular turn around the stump.

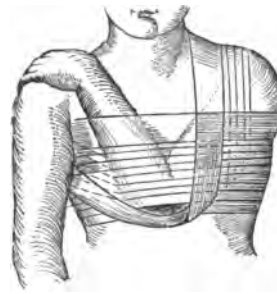
Use—To support the flaps of the stump after amputation.

Velpeau's Bandage. Position of the arm: hand of the injured side grasping the sound shoulder. Length of roller, ten to twelve yards; width, two and one-half inches.

Origin—The axilla of the sound side.

Course—Obliquely upward across the back of the chest to the seat of the fracture, over the compress, covering the seat of the fracture, down across the outside of the arm to *under* the elbow, in front of the chest to the axilla of the sound side, thence by a circular turn across the back *over* the outside of the point of the elbow to the axilla of the sound side. Continue the oblique and circular turns alternately, advancing over the arm and ascending from the point of the elbow until the arm is firmly supported (Fig. 48).

Fig. 48.



Termination—By circular turn around the chest.

Use—To support the arm in the treatment of fracture of the clavicle, the neck, or acromion process of the scapula.

In applying this bandage, a compress of soft material should be placed between the arm and the surface of the chest to prevent excoriation.

Desault's Apparatus. This consists of three single-headed rollers, a triangular pad to place in the axilla, and a sling to support the hand.

The pad should be of such length as to extend from the axilla to the point of the elbow, and measure in width at

the base from three to four inches. Length of rollers, eight yards; width, two and one-half inches.

FIRST ROLLER. *Origin*—Over the apex of the pad; placed in the axilla of the injured side.

Course—Two circular turns around the chest over the apex of the pad, thence by spiral turns upward to the axilla, covering the pad and securing it in place.

Termination—By circular turns around the chest.

This roller can be dispensed with to advantage, and the pad held in place by tapes attached to its base passing around the neck. The arm should now be flexed at a right angle, pressing slightly against the side of the chest.

SECOND ROLLER. *Origin*—Axilla of the sound side.

Course—Circular turn across the front of the chest, over the upper part of the arm of the injured side, across the back of the chest to the point of origin, then by spiral turns *descending* to below the point of the elbow.

Termination—Circular turns around the body.

Use—To throw the shoulder outward by pressing the elbow inward, using the pad as a fulcrum.

THIRD ROLLER. *Origin*—Axilla of the sound side.

Course—Obliquely upward across the front of the chest to the seat of the fracture, over the seat of the fracture, down back of the arm to the elbow, under the elbow, across in front of the chest to the point of origin; thence obliquely upward across the back of the chest to the seat of the fracture, over the seat of the fracture, down in front of the arm, under the elbow, across the back of the chest to the point of origin (Fig. 49).

Termination—Circular turns around the chest.

Use—To carry the arm upward and backward.

It will be observed that two triangles are formed in

applying the third roller, the first having the base *behind* the arm, the sides across the *front* of the chest, and the apex in the axilla of the sound side; while the second has the base in *front* of the arm, the sides across the *back* of the chest, and the apex in the axilla of the sound side.

USE OF THE APPARATUS.—To support the arm and overcome its displacement in the treatment of fractures of the clavicle.

Fig. 49.

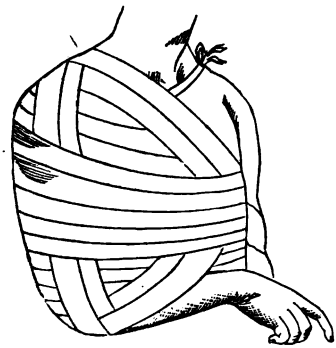
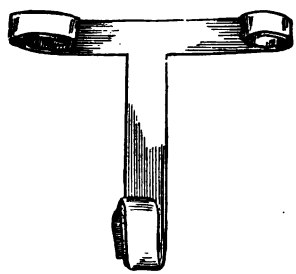


Fig. 50.



THE COMPOUND BANDAGES.

Under this name are included—

1. The T bandages.
2. The invaginated bandages.
3. The sling bandages.
4. The suspensory bandages.

1. The T Bandages. These derive their name from their resemblance to the letter T, and consist of a horizontal portion, sufficiently long to surround the part to be covered, and a vertical piece half the length of the hori-

zontal, firmly attached to its middle (Fig. 50). The bandage thus formed can be applied to various parts of the body. It is most frequently employed in retaining dressings to the perineum, when the horizontal portion is fastened around the body and the vertical band passed between the thighs and then attached to the horizontal piece. The napkin worn by women during menstruation is a familiar example of this form of bandage.

Fig. 51.

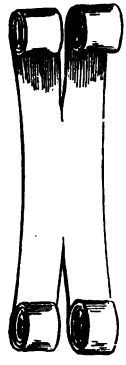


Fig. 52.

2. The Invaginated Bandage. This bandage is formed by making strips or tails at the free extremity and at the proper distance cutting slits in the body of the bandage through which these tails pass. It was formerly used

for the purpose of approximating the edges of wounds, but is now largely, if not altogether, discarded.

3. The Sling Bandages. These are made of pieces of muslin or other material of various lengths and widths, torn at each extremity into two or more tails, leaving a central portion or body (Fig. 51). They are quite useful in retaining dressings or supporting parts. In applying them, the central portion or body is placed upon the part, and the tails are carried in different directions about the part, and secured by pins or knots. The Four-Tailed or "Poor Man's" Bandage is used in the treatment of fracture of the body of the lower jaw (Fig. 52).

4. The Suspensory Bandages. These are made in the shape of bags or sacs of various sizes, and are used for the purpose of retaining dressings or supporting parts. They may be made of such material as is deemed most desirable.

MAYOR'S SYSTEM OF HANDKERCHIEF DRESSINGS.

This system of provisional dressings was introduced by M. Mayor, of Switzerland, in 1838. It consists in the use of the simple handkerchief, folded into various shapes, so as to accomplish the purposes of the roller. The dimensions of this handkerchief vary according to the part to which it is applied, and may be made of any material which happens to be at hand. The forms into which the handkerchief may be made are: THE SQUARE, THE TRIANGLE, THE CRAVAT, and THE CORD.

The Oblong Square is made by folding the handkerchief once on itself.

The Triangle is made by folding the square so that the angles which are opposite come in contact.

Fig. 53.

Fig 54.

The Cravat is made by folding the handkerchief in the form of the ordinary cravat.

The Cord is formed by twisting the cravat on itself.

Fig. 55.

Fig. 56.

The handkerchief in the form of the Square may be employed to retain dressings over the head.

In the form of the Triangle it can be used for the purpose of retaining dressings over the head (Fig. 53), the trunk, the shoulder, the elbow, the hand, the hip, the knee, and the foot; also to support or retain dressings over the mammary gland (Fig. 54), to act as a sling for the arm (Fig. 55), or to cover the stump after amputation (Fig. 56). In applying the handkerchief in the form of the Triangle, the base is to be applied to the part, and the angles carried about it and fastened by a knot.

The Cravat may be used to retain dressings, to make pressure, or to support parts, as the arm (Fig. 57) The body should be applied over the part, and the ends carried once or twice around the part and fastened by a knot. The handkerchief in the shape of the cravat may be used to fasten the foot to the end of the fracture-box in cases of fracture of the leg. It should be applied by a figure-of-8 turn, the body being placed over the tendo Achillis, and the ends carried across the instep and passed through the openings made in the end of the box, and then fastened by a knot.

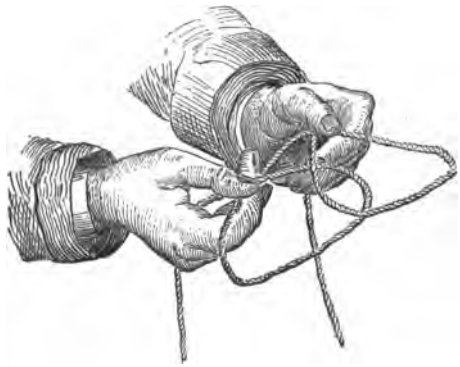
Fig. 57.

The Cord is used where it is necessary to make firm

pressure, as when it is applied over a compress in cases of hemorrhage. It may also be used in the form of the clove hitch for the purpose of making traction. The clove hitch

Fig. 58.

Fig. 59.



is made by holding one end of the cord with the left hand and forming from the body a simple loop with the right (Fig. 58); holding this between the thumb and finger of the left hand, a second loop is made from the remaining portion of the body of the cord and held by the thumb and finger of the right hand; passing the second loop beneath the first, the hitch is formed (Fig. 59).

IMMOVABLE BANDAGES.

THE STARCH BANDAGE, THE PLASTER OF PARIS BANDAGE, and THE SILICA BANDAGE.

1. **The Starch Bandage.** In this form of bandage, the starch should be prepared so as to be of the same consistence as that used in the laundry. Before applying the roller, two compresses made of some soft material, folded so as to be at least one inch in thickness and of the same breadth as the limb, should be applied along each side, extending from the point at which the application of the bandage begins to the point at which it terminates. Holding these carefully in position, the first roller is applied to the limb. This roller is now thoroughly coated with the starch by means of a medium-sized paint-brush, the interstices and spaces being well filled. Over this a second roller is applied and coated with the starch in the same manner. In this way a sufficient number of rollers should be applied until the parts are properly supported. If necessary, strips of pasteboard which have been soaked in the starch may be placed on the sides of the limb, after the second bandage has been applied, about those points requiring most support.

The compresses, which are placed on the sides of the

limb, serve the purpose of protecting it from undue pressure, caused by the drying of the starched bandages. They may be applied dry, or they may be soaked in the starch and then applied. In the leg they are especially serviceable in preventing pressure over the crest of the tibia, the two borders of the compresses which are separated to a slight extent supporting the bandage and keeping it from too close contact with the limb.

2. The Plaster of Paris Bandage. This bandage may be applied with rollers made of some loosely woven material, such as crinoline, Swiss muslin, or mosquito-netting, or with the ordinary muslin. When the first is used, it should be cut into strips, and dry plaster rubbed with the hand into its meshes on both sides; and then the strips should be formed into rollers and put in an air-tight tin vessel. When required, the rollers should be placed *on end* in a basin, containing water enough to cover them entirely, for one or two minutes, in order that they may become thoroughly wet, and in this condition they should be applied rapidly to the part; a free escape of bubbles of gas through the water takes place, and, when this has ceased, the bandages are ready for application.

The roller, made of the ordinary muslin, can be prepared by unrolling it in a basin containing water, thus becoming wet as it unrolls, and re-rolling it in a basin containing a mixture of plaster and water of the consistency of cream. In this way the surfaces become well coated with the plaster, and the roller can be applied directly to the part. In applying the plaster bandage, the mixture of plaster should be rubbed over each roller with the hand after it is applied. The setting of the plaster may be retarded by add-

ing a little size or stale beer. If salt is added, its tendency to set will be increased. Gum-water, white of egg, or flour-paste should be applied to the surface after hardening has occurred, in order to prevent chipping; a coat of varnish will render it impermeable to moisture. In this form, the compresses should be placed along the sides of the limb in the same manner as in the starch bandage.

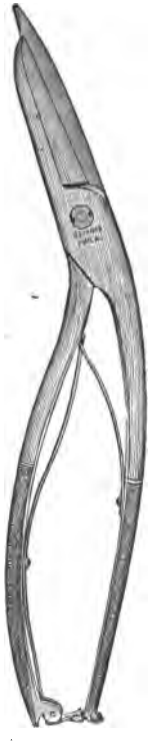
3. **The Silica Bandage.** In preparing this bandage a solution of the silicate of potassium or sodium is used. The roller is applied to the limb over the compresses, placed as above described, and it is thoroughly coated with the solution by means of a medium-sized painter's brush. As many rollers as may be deemed necessary are applied, each being thoroughly coated with the solution.

This is an excellent form of the immovable bandage, being easily applied, lighter than the plaster bandage, and hardening in a very short time.

In addition to these forms of immovable bandages there are the Dextrine, the Gum-and-Chalk, the Glue, and the Paraffin bandages. These do not possess any advantages over those described above; the end to be accomplished —immobility of the parts—being secured by one as well as by the other.

Great caution should be observed in applying the rollers in these forms of bandage lest too much traction be employed; they should be applied with *less traction* than the ordinary roller, owing to the shrinkage which occurs, and which thus increases the pressure. The parts should be carefully watched after the application has been made, in order to note any changes which may occur, indicating too much pressure or interference with the circulation. Should

Fig. 60.



evidences of these conditions manifest themselves, the bandages should be immediately removed, the limb sponged with soap liniment or alcohol and laudanum, and the dressings re-applied with more care.

In some forms of the immovable bandages, great difficulty is experienced in effecting their removal. Strong-cutting pliers have been made, with which the bandages can be divided, the instrument being carried along the side of the limb (Fig. 60). The starch bandage requires to be removed by this instrument. The plaster of Paris bandage can be easily unrolled from the part, or, if very thick, dilute hydrochloric acid may be applied along the side for a few minutes, softening the plaster, so that it can be divided by the scissors. The silica bandage may be readily removed after soaking it for a time in warm water.

Sayre's Suspension Apparatus for applying the Plaster Jacket. This is an apparatus devised by Professor Lewis A. Sayre, of New York, for the purpose of suspending patients suffering from antero-posterior curvature of the spine during the application of the plaster of Paris bandage. The object to be accomplished by the suspension of the patient, is the separation of the diseased vertebræ, and the straightening, to a certain extent, of the column,

the bandage being applied when the patient is suspended. When it hardens, it prevents the recurrence of the curvature to the same extent as before, by offering a firm support to the parts.

The apparatus consists of a curved iron cross-beam, to which is attached an adjustable head and chin collar, with straps fitted to axillary bands. To a hook in the centre is fixed a compound pulley, the other end of which is secured either to a hook in the ceiling, or to the top of an iron tripod about ten feet in height (Fig. 61). In applying the plaster jacket, "the surface of the skin should be protected by an elastic but closely fitting shirt or vest, without armlets, with tapes to tie over the shoulders, and composed of some soft, warm, or knitted material;" a thin and closely fitting

Fig. 61.

merino undershirt can be thus prepared. When the patient is a developing girl, pads should be placed over each breast, to be removed just before the plaster has completely set. Another pad, composed of cotton loosely folded up in a handkerchief, is to be placed over the abdomen; it should be very thin at its lower part, so as not to make the jacket too loose. On the same principle, small pads are applied at either side of tender spots over prominent bony processes, and two folded cloths, three or four thicknesses each, just over the anterior iliac spines. The shirt being accurately applied, and kept smoothly stretched by means of the shoulder-tapes above and two tapes below, one in front and the other behind, tied over a handkerchief placed in the perineum, the patient is to be drawn up gently *until he feels comfortable* (Fig. 62).

Fig. 62.

A prepared and saturated roller, gently squeezed so as to get rid of all surplus

water, is now applied around the smallest part of the body, and carried around the trunk downwards to a little below the crest of the ilium, then spirally from below upward until the entire trunk is encased from the pelvis to the axillæ. The bandage should be applied smoothly, and not drawn tight.

"After one or two thicknesses of bandage have been thus applied, several narrow strips of roughened tin are laid on either side of the spine, so as to surround the body, with intervals between them of two or three inches. Over these another plaster bandage is applied; very soon the plaster sets so firmly that the patient can be removed and laid upon his face or back upon a hair-mattress or air-bed. The pads are then removed, and the plaster gently pressed in with the hand in front of each iliac spine, so as to widen the case over the bony projections. While the patient is thus lying, it is sometimes necessary to wet the jacket with a little water, and then dust on some more plaster. As soon as the plaster has hardened, the patient may be allowed to walk about."

The jacket is generally removed, after two or three months, by dividing it with the cutting pliers, knife, or a very narrow saw, from the pubes to the sternum, and gently stretching it apart.

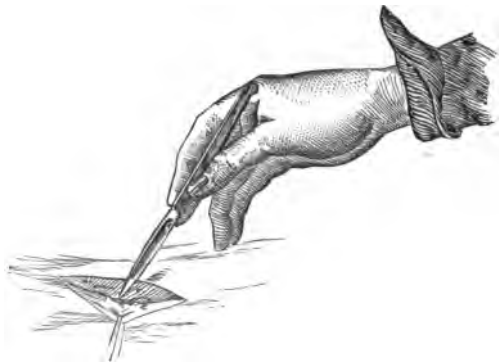
PART III.

LIGATIONS.

LIGATIONS are surgical procedures, and require the employment of cutting instruments. In performing them, the methods of holding the knife, of making the incisions, and of closing the wound, vary.

Positions of the Knife. There are three principal positions in which the knife may be held. In the *first*

Fig. 63.



position (Fig. 63), it is held as the pen in writing, the cutting edge being turned downward or upward.

In the *second position* (Fig. 64), the handle of the instrument is grasped firmly in the hand as a table-knife is held. The handle lies in the palm, supported strongly between the thumb, middle, ring, and little fingers, whilst the index finger is slightly extended along the back of the blade. In using the knife in this position, the cutting edge may be turned upward or downward.

Fig. 64.

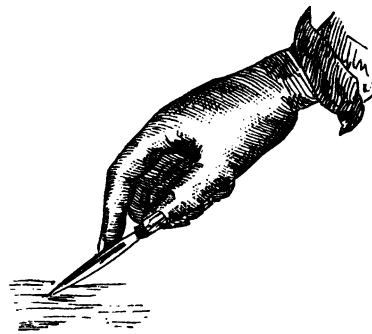
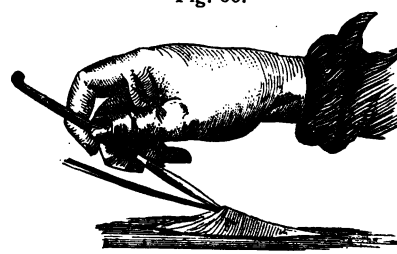


Fig. 65.

Fig. 66.



In the *third position* (Fig. 65), the knife is held as the bow of the violin—lightly balanced between the thumb and fingers. In this

position, also, the edge may be turned upward or downward (Fig. 66).

Incisions. The incisions which are employed may be STRAIGHT, CURVILINEAR, or ANGULAR, and may be made from *without inward* or from *within outward.*

The *straight incision* (Fig. 67) is that most commonly used, and may be made in a vertical, oblique, or transverse direction.

The *curvilinear incision* (Fig. 68) is used where it is

Fig. 67. Fig. 68. Fig. 69.

desirable to conform to the shape of the part involved, or where large space is required for the purposes of the operation. Two curvilinear incisions meeting at their extremities form the elliptical (Fig. 68).

The *angular incision* (Fig. 69) is composed of two or more straight incisions placed at different angles—as the right angle forming the letter **L**, or the acute angle forming the letter **V**, etc.

In making incisions from without inward, the integument should be put upon the stretch; by this plan the incision is made with precision, and the integument is preserved. In order to make the incision from within outward, a fold of the integument should be held up and its base transfixed by the knife, which should cut its way out. This method is employed where great caution is required in dividing the superficial tissues. The knife should be held lightly yet firmly, and the movements necessary to carry it through the tissues should, as a rule, be made with

the fingers, and not at the wrist or elbow-joint. Very long incisions may require a sweeping movement made with the entire arm. In cutting from without inward, the edge of the knife should be held lightly in contact with the surface, not pressed into the tissues. "Dexterity, grace, and elegance," in using the knife, can be acquired only by practice and careful study.

Closure of Wounds. In order to retain the edges of wounds in close apposition, so that union may take place, the introduction of sutures is necessary.

The Sutures. The material used may be silk or linen, animal tissue or metal. The metallic suture may be made of silver, iron, or lead-wire. The suture may be fastened by a square knot, or, as in the metallic suture, by twisting the ends or clamping shot upon them. When the metallic suture is used in a cavity, as the mouth or vagina, the cut ends can be covered by clamping a shot on them, so as to prevent them from penetrating the tissues, and thus causing pain. The knots or twisted ends should always be placed on the *side* of the incision, and not *over* it.

The principal forms of sutures employed are the INTERRUPTED, the CONTINUED, the TWISTED, and the QUILLED.

The *interrupted*, *continued*, and *quilled* sutures are made by the insertion of a needle armed with a thread made of silk, linen, or wire.

In the *interrupted suture* (Fig. 70) the needle is carried through the edge of the wound from without inward, at a proper distance from the border, across the wound, and pushed from within outward at exactly the same point on the opposite side. The thread is then cut, and another suture introduced either above or below.

The *continued suture* (Fig. 71) is made by passing the needle diagonally from one side of the wound to the other.

Fig. 70.

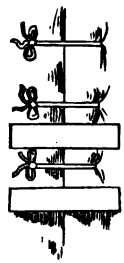
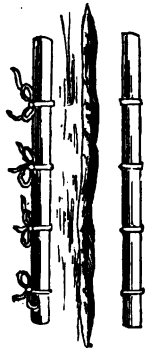


Fig. 71.

Fig. 72.



In this suture, the thread is not cut until a sufficient number of sutures have been introduced to hold the edges in apposition.

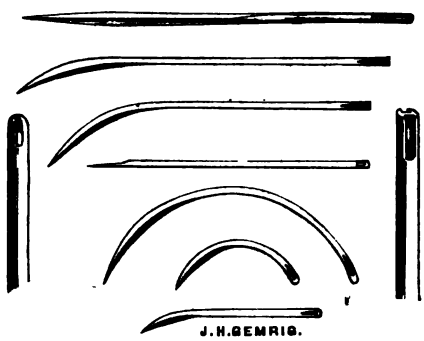
The *quilled suture* (Fig. 72) is formed by passing through the lips of the wound a needle armed with a double thread. The ends of the thread are tied over pieces of quill, bougie, or light wood, placed parallel to the edge of the incision. This suture is employed in approximating the edges of deep wounds.

Fig. 73.

The *twisted suture* (Fig. 73) is made by introducing a pin made of steel, commonly called the hare-lip pin, through the edges of the wound, and carrying a thread round it in an *elliptical* manner, so as to hold it in place. The pin is

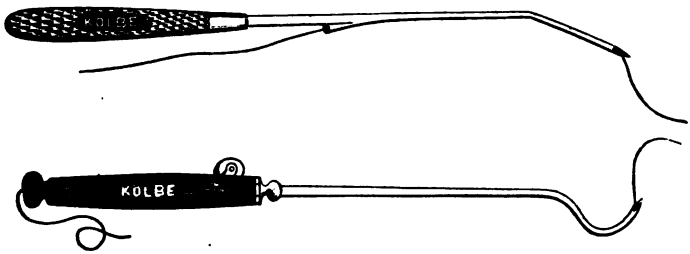
passed through the deeper parts of the wound, approximating them, while the thread brings the superficial portions in contact.

Fig. 74.



Needles. The needles employed to pass the threads in forming sutures may be either straight or curved, round, triangular, or double-edged (Fig. 74). They may be mounted on

Fig. 75.



handles, and may be cannulated (Fig. 75), and provided with special appliances for facilitating the passage of the thread or wire.

OPERATIONS UPON THE LIVING AND DEAD SUBJECTS.

As the knowledge of the student is to be acquired in operations performed upon the dead subject, it is important

for him to understand that a marked difference exists with regard to the character of the tissues and the manner in which they separate under the edge of the knife in the living and the dead subjects. This difference should be carefully noted, so that when he undertakes operations upon the living subject he may avoid errors.

In the living subject the soft tissues possess a great amount of elasticity and power of contractility. The former property resides to a marked degree in the common integument, and thus adapts it in an admirable manner to the purposes of a common covering of the body. In the muscular structures the power of contractility is very great, varying, of course, in proportion to the size and amount of tissue involved.

In the dead subject these conditions are entirely absent: it is true that in the recently dead subject a small amount may exist, but it may, however, be regarded as practically wanting. In the subject which has been injected with such an agent as chloride of zinc, and kept for a period of time in a solution of salt, elasticity and contractility of the tissues are not only absent, but there exists, in fact, as a result of this method of preservation, an induration which is altogether unnatural, and which impairs to a great degree the value of the subject for anatomical or surgical purposes. The color and appearance of the tissues as well as the texture are altered, so that these cannot be taken as guides in recognizing different structures. In the living subject a very slight exertion will carry a sharp knife easily and smoothly through the tissues—almost, it may be said to glide through without any effort on the part of the operator. In the dead subject, on the contrary, an effort is required to pass the knife through the structures, and in a subject prepared as above described, some force is necessary to

divide them. The resistance offered by the tissues of the dead subject is well shown in the effort to introduce the catheter in the cadaver. Sometimes it is impossible to accomplish it, and even when done it has required so much force as to inflict injury upon the parts. The information derived from the operation is therefore of little practical value, since in the living subject the instrument is simply guided through the canal, passing almost by its own weight. The student will find, therefore, in passing from operations upon the dead to those upon the living subject, that unless he exercises great caution he will overestimate the resistance of the tissues and fail to make his incisions as contemplated.

INSTRUMENTS USED IN THE LIGATION OF ARTERIES.

Instruments. The instruments required to perform operations for the application of ligatures to arteries, are:

Fig. 76.

1. *A knife*—That known as the scalpel, an instrument having a sharp point and a broad body or belly (Fig. 76).

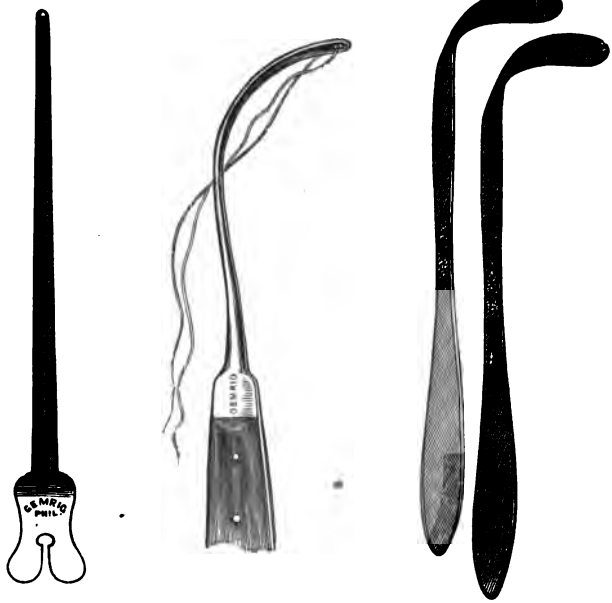
2. *A pair of dissecting forceps* (Fig. 11) to seize and hold the tissues, as may be necessary, in their division. The forceps should be held between the thumb and index and middle fingers.

3. *A grooved director*—A blunt-pointed director, from four and a half to five inches in length, with a groove upon its upper surface (Fig. 77). It is used to introduce beneath layers of tissue before dividing them, and also to separate the delicate fascia enveloping vessels.

4. *A Ligature Needle*—A curved, blunt-pointed needle having an eye near its point, and mounted in a handle so as to enable it to be conveniently carried around the artery (Fig. 78).

5. *Ligatures*—Threads made of various materials: silk, flax, animal tissue, or metal. They should be cut from fourteen to eighteen inches in length.

Fig. 77. Fig. 78. Fig. 79.



6. *Spatulas*—Instruments formed from metal, curved at one extremity, and of sufficient length and breadth to hold conveniently the edges of the wound apart (Fig. 79).

7. *Scissors*—The ordinary straight surgical scissors.
8. *Suture needles.*
9. *Sutures.*

In performing the operation upon the living subject, there would be needed, in addition, adhesive plaster, cut into strips, to support the edges of the wound, a compress to cover the surface of the wound, and a roller to confine the dressings and afford gentle support to the parts.

OPERATIONS FOR THE LIGATION OF ARTERIES.

General Considerations. In order to perform the operation for the ligation of arteries properly, it is essential that the student should have a thorough knowledge of the anatomical relations of the structures concerned in the operation. He should be able, as it were, to see through the parts—to have a mental picture of the structures, layer after layer, from the surface to the position occupied by the vessel. He should have such familiarity with the appearance of the various tissues as will enable him to distinguish them promptly—their color and the arrangement of their fibres. He should know so well the course of the vessel that he can make the incision directly over and parallel to it, and not across it. He should not commence the incision by hunting for the artery, but should proceed intelligently, seeking as he advances for well-known and well-established guides or landmarks, structures of importance and having important relations to the vessel he seeks.

The student, in operating upon the cadaver, is especially cautioned against want of care and undue haste; it is too frequently observed that many are satisfied with simply finding the vessel, without possessing any definite knowl-

edge with regard to its position and relations. As a result of such imperfect methods it not unfrequently happens that the ligature is found to surround a vein, nerve, tendon, or even a portion of muscular tissue or fascia, instead of the artery.

Every operation performed for the ligation of an artery can be divided into three well-defined stages. The first stage embraces that part of the operation which relates to reaching or exposing the artery or its sheath; the second includes the isolation or separation of the artery from the surrounding or accompanying structures: in the third, the operation is completed by the application of the ligature and the closure of the wound. It is in the first stage of the operation that the anatomical knowledge of the operator is especially to be brought into play. He should carefully inspect the limb or part so as to fix the important external landmarks or surface markings; he should also feel it, so as to determine the nature of the structures causing projections upon the surfaces. He should fix accurately the points between which the vessel passes, and define its course; he should recall its general relations in its entire extent, and its particular relations at the point of ligation. He should note carefully the character of the structures having particular relations, whether bloodvessels or nerves, and therefore to be approached with great caution, or muscles or tendons which serve as rallying points or guides. After the incision of the skin and superficial fascia has been made, these guides should be sought for in order until the vessel is reached.

When the artery has a sheath, inclosing with it a vein or a vein and a nerve, its isolation should be effected with great care, so as to avoid inflicting injury upon the accompanying structures.

As the coats of the artery receive their vascular supply from the nutrient vessels which ramify in the loose areolar tissue connecting the artery with the sheath, it is important that this should be destroyed to as slight an extent as possible. As a rule, the separation should not be more than one-half of an inch. This rule should be observed in separating the artery from surrounding structures, under all circumstances, as suppuration is more liable to occur when the tissues are much disturbed and broken up.

In passing the ligature around the artery, the point of the instrument should be carried *always* from the vein, so that the point cannot penetrate it; if a vein is not present, then the ligature should be passed from the nerve. If the vessel is accompanied by venæ comites, these should be gently separated before passing the ligature. Before tying the ligature, careful examination should be made to see that the nerve is not included.

In making the incisions to expose the artery, the skin over the part to be divided should be held firmly between the thumb and index finger of the left hand, while the knife, held in the position of the pen in writing, should be introduced in a vertical direction, the point penetrating the skin, and, to a slight extent, the superficial fascia; then, depressing the handle of the knife, it is drawn downward or upward as the case may be, dividing the tissues to the proper extent, and withdrawn in the vertical direction, the movements necessary to accomplish this being made by the fingers and at the wrist-joint. This first incision should be free, and cleanly cut. The fascia is now seized by the dissecting forceps at the lower angle of the incision, elevated, and a small incision is made with the scalpel (Fig. 80). Through this opening the point

of the grooved director is introduced, and gently pushed to the upper angle of the incision. The knife is now

Fig. 80.

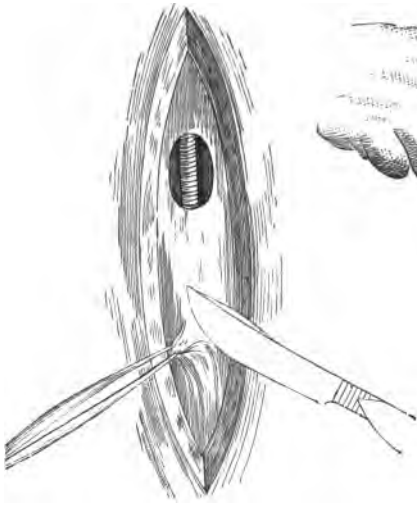
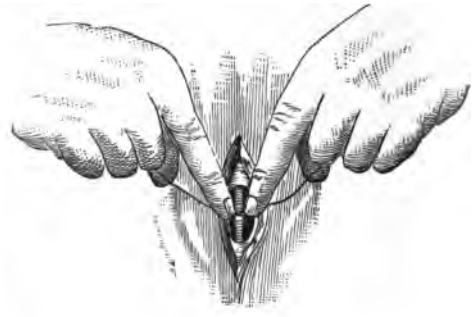


Fig. 81.



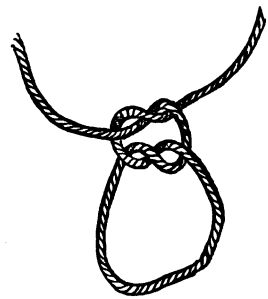
carried along the groove (Fig. 66), dividing the fascia and liberating the director. Before incising the fascia raised upon the director, it should be examined carefully in order to detect any vessels or nerves which it may contain. If these are of sufficient importance they can be held aside, while the fascia is divided, or, if necessary, the vessels may be ligated and then divided. Each layer of tissue is to be divided in this manner until the sheath of the artery is reached. This is opened by seizing it with the forceps and making a slight nick, of sufficient size to admit the point of the ligature needle. Through

this opening the point of the grooved director is inserted, and the artery is gently and cautiously separated from the sheath and the accompanying structures. The ligature needle, having been armed, is now introduced through the opening, the point kept in close contact with the artery and carried around it in a direction from the vein or nerve and brought out on the opposite side. One thread of the ligature is now seized with the forceps, and held firmly while the needle is withdrawn.

The artery thus surrounded should be raised gently from its bed, and examined to see that no other structure is included in the ligature. This being determined, the ligature is tied with a square or reef knot (Figs. 81, 82),

Fig. 82.

Fig. 83.



care being taken to avoid making the "granny" knot, which is liable to slip (Fig. 83); one end is cut off close to the knot, and the remaining one is allowed to pass directly out of the wound.

The wound is now closed by two or more sutures, the knots being placed on one side of the incision and not

over it, adhesive strips and compress are applied, and the parts gently supported by a few turns of the roller.

Some of the more important points relating to the different steps of the operation may be embraced in a few general rules, which will assist the student in fixing them upon his mind.

I. Make the incision directly over and parallel to the course of the artery, not across it. Unless the incision is made very wide of the course of the vessel, this plan will give ample room. The tissues can be separated by the spatulas, so as to increase the space, when required. If the oblique incision is made, and is carried into the deeper part of the wound, the muscular structures would be divided across their fibres, which is objectionable, and not parallel with them.

II. Dissect directly down to the artery. Avoid lateral dissections and disturbance of the surrounding structures.

III. Separate the artery from its sheath to the slightest extent possible.

IV. Do not use the point of the knife in the wound after the sheath of the vessel has been reached and opened. Use the handle of the knife and the grooved director to separate tissues.

V. Always pass the ligature from the vein, if present.

VI. Make the incision as small as possible, but always large enough to give ample working space and light. The external incision should be made to the extent required by the *first* stroke of the knife, so as to avoid subsequent incisions to enlarge it. These, when made, usually result in the production of irregular, jagged edges. A superficial artery requires a short incision, one lying deeper a longer incision.

VII. In closing the wound, the needle should be inserted at such distance and depth from the edge as to resist tension,—as a rule, not less than half a line, nor more than a quarter of an inch. Two-thirds of the thickness of the edge should be supported by the suture.

In describing the ligations of the various arteries, a plan has been adopted which, it is thought, will assist the student materially, not only in performing the operations, but in studying them. An effort has been made to present the subject in a systematic manner, so that when the operation is undertaken the student will find information which will enable him to proceed intelligently through each step, and, when finished, study it as a complete operation.

In each description the following order has been observed: —

I. The course of the vessel is stated, the direction which it takes in passing between certain points—fixed or imaginary.

II. External guides or surface markings are given. These may exist as bony projections or borders of muscles which appear prominently upon the surface; they are important in fixing the relations of the vessel to the external surface.

III. The general anatomical relations which the vessel has are given in detail, and also the particular relations at the point of ligation. These acquaint the student with the entire surroundings of the vessel, informing him of their nature.

IV. Internal guides, landmarks, or rallying points, which are to be sought for as the operation progresses, are noted in each case.

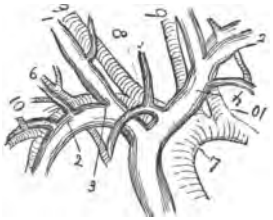
V. Certain structures, as veins and nerves, have relations to each important artery, and are to be carefully avoided. These are stated in the order of their importance, and in certain operations special attention is directed to their presence.

VI. Some of the larger arteries are embraced in a common sheath with the vein, and sometimes a nerve. When this arrangement exists it is stated.

LIGATION OF SPECIAL ARTERIES.

The Innominate Artery. SURGICAL ANATOMY.—Before attempting to ligate this vessel the student should endeavor to obtain a clear idea of the relations it has to the very important structures which surround it. It is the largest branch given off from the arch of the aorta, and is from an inch and a half to two inches in length (Fig. 84). Its

Fig. 84.



Innominate Artery.

1, 1. Internal jugular veins.
2, 2. Subclavian veins.
3. Right innominate vein.
4. Left innominate vein.
5. Inferior thyroid vein.
6. External jugular vein.
7. Arch of the aorta.
8. Innominate artery.
9, 9. Common carotid arteries.
10, 10. Subclavian arteries.

point of origin, from the transverse portion of the aorta, is about one inch below the margin of the sternum, and on a line with the second costo-sternal articulation. It is in intimate relation with the two large venous trunks—the right and left innominate veins—the right inferior thyroid

vein crossing its front in an oblique direction. On the right side it has in close proximity the right pneumogastric nerve and the pleura; it rests upon the trachea, and to the left has in relation the left carotid artery. It will be observed, therefore, that on all sides are placed the most important structures, which require the utmost care to avoid. Not only should these structures be carefully guarded against injury, but in any operation which is performed they should be disturbed to the slightest extent possible. The causes of failure in efforts which have been made to surround this vessel with a ligature in the living subject are stated to have been repeated secondary hemorrhages and inflammation of the pleura and lung.

Course—Obliquely upward from point of origin from the commencement of the transverse portion of the arch of the aorta to the sterno-clavicular articulation of the right side.

Surface markings—Sterno-clavicular articulation. Fossa above the clavicle, indicating the interval between the two heads of the sterno-cleido-mastoid muscle.

General relations: In front—Sternum, sterno-hyoid, and sterno-thyroid muscles; remains of thymus gland; left innominate and right inferior thyroid veins, and cardiac branches of the right pneumogastric nerve.

Behind—The trachea.

Right side—Right innominate vein, pneumogastric nerve, and the right pleura.

Left side—Remains of the thymus gland and the left carotid artery.

Guide—The sterno-cleido-mastoid muscle.

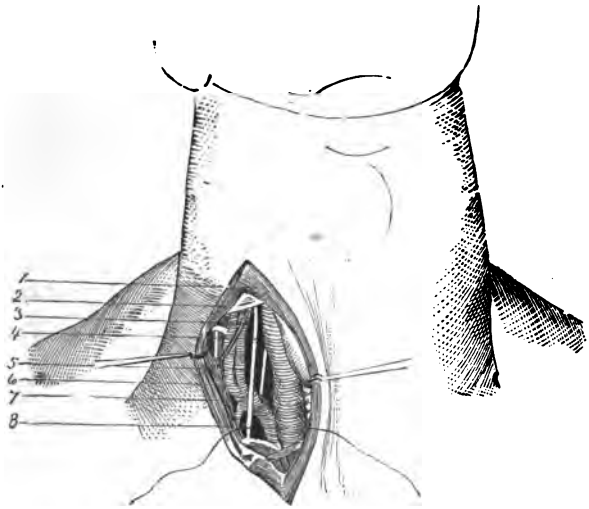
Structures to be avoided—The middle and right inferior thyroid, the anterior and internal jugular, and the right innominate veins; the pneumogastric nerve.

OPERATION.—Raising the shoulders, inclining the head slightly backward and to the left side, so as to render tense the right sterno-mastoid muscle, and project the innominate artery into the neck, an incision, three inches in length, dividing the skin, should be made from below the clavicle upward over the fossa, indicating the interval between the two heads of the sterno-mastoid muscle. The superficial fascia, platysma myoides, and anterior layer of the deep fascia, are now carefully divided on the grooved director. Flex the head slightly, and separate with the fingers the heads of the sterno-mastoid muscle, the connecting areolar tissue having been divided. Divide carefully on the director the deep layers of the cervical fascia, and, if necessary, the sterno-hyoid and sterno-thyroid muscles transversely. These incisions will expose the point of bifurcation of the artery into the carotid and subclavian arteries. Passing downward from this point the artery can be reached, and the ligature applied from *right* to *left*, so as to avoid the right innominate vein (Fig. 85). The innominate artery can also be reached by an incision, two inches in length, made along the anterior border of the sterno-mastoid muscle, terminating at the clavicle. From this point a second incision, to the same extent, is carried along the upper border of the clavicle. The points of attachment of the platysma, the sterno-mastoid, sterno-thyroid, and sterno-hyoid muscles are to be divided as they are exposed. Dividing carefully the fascia, and separating other structures, the right carotid artery is brought into view; tracing this downward, the innominate artery can be reached and ligated.

The advantages claimed for the method first described are, in avoiding the section of the muscles, and the greater

ease with which the artery is approached. While, in all cases, it is desirable to divide the tissues to as slight an ex-

Fig. 85.



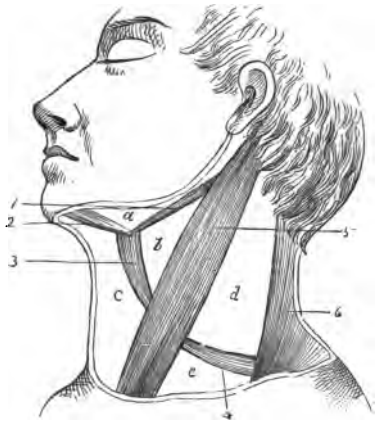
1. Internal head of sterno-mastoid muscle.
2. External head of sterno-mastoid muscle.
3. Vertebral artery.
4. Pneumogastric nerve.
5. Recurrent laryngeal nerve.
6. Internal jugular vein pulled aside.
7. First part of subclavian artery and its branches.
8. Innominate artery.

tent as possible, it is, nevertheless, of great importance that the operator should not be embarrassed by want of ample working space. Great injuries may be inflicted upon structures in the effort to save those of less importance. In this operation it is sometimes impossible to avoid

wounding some of the larger venous branches in relation with the artery; when this occurs they should be ligated, or, when it is necessary to divide them, two ligatures should be applied, and the vein cut between.

The Triangles of the Neck. Before passing to the operations upon the arteries which occupy the region of the neck, the student should, in connection with the study of their relative anatomy, also carefully examine these structures collectively. On examination it will be found that these vessels, with other important structures, occupy

Fig. 86.



1. Posterior belly of the digastric muscle.
2. Anterior belly of the digastric.
3. Anterior belly of the omo-hyoid muscle.
4. Posterior belly of the omo-hyoid.
5. Sterno-cleido-mastoid muscle.
6. Trapezius muscle.

a. Digastric, or submaxillary triangle.
b. Superior carotid triangle, or triangle of election.
c. Inferior carotid triangle, or triangle of necessity.
d. Occipital triangle.
e. Subclavian triangle.

Triangles of the Neck.

certain well-defined spaces, which can be readily outlined, and which are formed by prominent muscular and bony structures (Fig. 86). The side of the neck is somewhat quadrilateral in shape: bounded above, by the lower

border of the body of the jaw and an imaginary line extending from the angle of the jaw to the mastoid process of the temporal bone; below, by the upper border of the clavicle; in front, by the median line of the neck; and behind, by the border of the trapezius muscle. The sterno-mastoid muscle, crossing this space obliquely, divides it into two large triangles, the anterior and posterior. The former is bounded by the median line of the neck in front, the anterior border of the sterno-mastoid behind, and the border of the jaw and the imaginary line from the angle to the mastoid process above. This triangle is subdivided by the digastric and anterior belly of the omo-hyoid muscle into three smaller triangular spaces, named, from below upward, the inferior carotid, the superior carotid, and the digastric.

The inferior carotid triangle, or the "triangle of necessity," as it is sometimes designated, is formed by the median line of the neck in front, by the anterior border of the sterno-mastoid behind, and by the anterior belly of the omo-hyoid above. The common carotid artery passes through this space obliquely upward and backward, following the direction of the sterno-mastoid muscle, covered in part by the muscles which take origin from the sternum and clavicle.

The superior carotid triangle, or the "triangle of election," is bounded by the posterior belly of the digastric above, the anterior belly of the omo-hyoid below, and the anterior margin of the sterno-mastoid behind. In this space the common carotid artery lies superficial, and at the upper border of the thyroid cartilage divides into its terminal branches, the external and internal carotids.

The digastric triangle is limited above by the lower

border of the jaw, the parotid gland, and mastoid process of the temporal bone; behind by the posterior belly of the digastric and stylo-hyoid muscles, and in front by the anterior belly of the digastric muscle. The external and internal carotid arteries, with the internal jugular vein and pneumogastric nerve, pass through this space.

The posterior triangle is subdivided into two smaller triangles, by the posterior belly of the omo-hyoid muscle, the occipital and the subclavian.

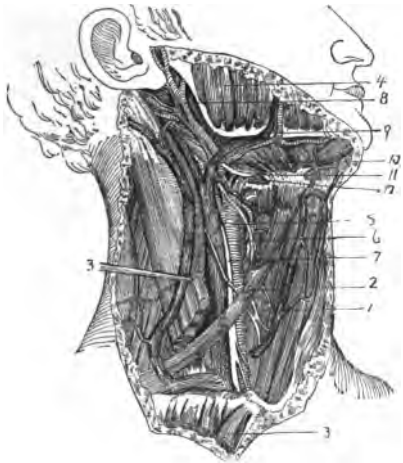
The occipital triangle is bounded, in front, by the posterior border of the sterno-mastoid; behind, by the anterior border of the trapezius; and, below, by the posterior belly of the omo-hyoid.

The subclavian, the smaller and more important of the posterior subdivisions, is formed by the posterior border of the sterno-mastoid in front, the upper border of the clavicle below, and the posterior belly of the omo-hyoid above. In this space is found the subclavian artery as it arches across the root of the neck.

The Common Carotid Artery. SURGICAL ANATOMY.—For the purposes of ligation, the common carotid artery may be divided into two parts, that above the anterior belly of the omo-hyoid muscle extending to the point of bifurcation opposite the upper border of the thyroid cartilage, and that below the muscle terminating at the sterno-clavicular articulation (Fig. 87). The upper portion lies in the superior carotid triangle (Fig. 86, *b*). Owing to the superficial position it occupies in this space, it is easily reached, and this is designated as the *point of selection.* At this part it is crossed obliquely from within outward by the sterno-mastoid artery, a branch of the superior

thyroid (the superficial descending branch), and also by the facial, lingual, and superior thyroid veins, which terminate

Fig. 87.



1. Sterno-thyroid muscle.
2. Omo-hyoid muscle.
3, 3. Extremities of the Sterno - cleido - mastoid muscle which has been divided.
4. Masseter muscle.
5. Common carotid artery, with filaments of descendens noni nerve on its anterior surface.
6. Internal jugular vein.
7. Pneumogastric nerve.
8. External carotid artery.
9. Facial artery with vein.
10. Internal carotid artery.
11. Hypoglossal nerve crossing the external carotid artery.
12. Lingual artery.

The Common Carotid Artery.

in the internal jugular. Below the omo-hyoid muscle the vessel occupies the inferior carotid triangle (Fig. 86, *c*). Here it is deeply placed, lying beneath the sterno-mastoid, sterno-thyroid, and sterno-hyoid muscles, which arise from the adjacent parts of the sternum and clavicle.

In this position, which is designated the triangle of necessity, its relations are somewhat more complicated than above, owing to the proximity of the vessels and other structures which converge to the root of the neck. On the right side the internal jugular vein separates from the artery, while on the left it approaches, and usually crosses, its lower part, in order to unite with the subclavian vein.

It is also to be remembered that the carotid arteries present frequently peculiarities relating to origin, point of bifurcation, and branches. In a surgical point of view, the most important peculiarity is that which relates to the point of division in the neck. In the order of infrequency, the points of division are given as the root of the neck, opposite the middle of the larynx or lower border of the cricoid cartilage, opposite the hyoid bone or beyond this point.

The artery occasionally gives origin to the superior thyroid or a laryngeal branch, the inferior thyroid or, very rarely, the vertebral artery.

After ligation of the common carotid artery, the collateral circulation is freely established both within and without the cranium by the branches of both carotid arteries and those of the subclavian artery on the side on which ligation has been performed. Outside, the superior and inferior thyroid and the profunda cervicis of the superior intercostal and arteria princeps cervicis of the occipital form the principal channels of communication, while, within the cranium, the vertebral artery takes the place of the internal carotid.

Course—From the sterno-clavicular articulation upward and backward to a point midway between the mastoid process of the temporal bone and the angle of the lower jaw.

Surface marking—The sterno-cleido-mastoid muscle.

General relations. Above the Omo-hyoid Muscle: In front—Skin, superficial fascia, platysma and deep fascia, anterior border of sterno-mastoid muscle, facial, lingual, and superior thyroid veins, sterno-mastoid artery, descendens noni nerve.

Below the Omo-hyoid Muscle: In front—Skin, superficial fascia, platysma and deep fascia, sternal head of the sterno-mastoid, sterno-hyoid and thyroid muscles, anterior jugular and middle thyroid veins.

Behind—Longus colli and rectus anticus major muscles, sympathetic nerve, inferior thyroid artery, and recurrent laryngeal nerve.

Inside—Pharynx, larynx, inferior thyroid artery, recurrent laryngeal nerve, thyroid gland, and trachea.

Outside—Internal jugular vein and pneumogastric nerve.

Guide—The sterno-cleido-mastoid muscle.

Structures to be avoided—Internal and anterior jugular veins, sterno-mastoid artery, descendens noni, and pneumogastric nerve. In the lower portion, the inferior thyroid artery, recurrent, laryngeal, and sympathetic nerves.

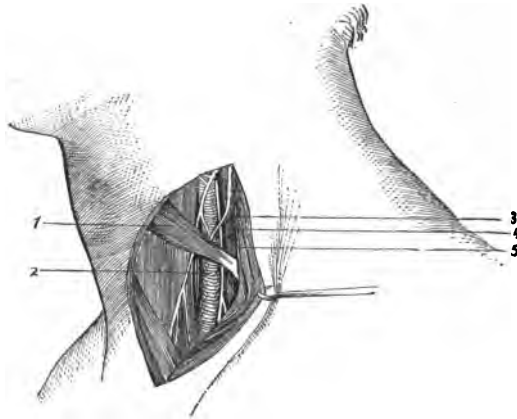
Common sheath—Including the artery on the inside, internal jugular vein on the outside, and the pneumogastric nerve behind and to the outside.

OPERATION.—Above the omo-hyoid muscle; in the triangle of election.

The head being thrown back and the face turned to the opposite side, an incision, from two and a half to three inches in length, is made, beginning opposite the greater cornu of the hyoid bone and passing downward along the anterior border of the sterno-mastoid muscle, dividing the skin. The superficial fascia, platysma muscle, and the layers of the deep fascia being divided carefully upon the director, the inner edge of the sterno-mastoid muscle is exposed. Lying beneath this, separated by a layer of the deep fascia, is found the common sheath of the vessels, with the descendens noni nerve upon its anterior surface.

Pushing this gently aside, the common sheath is now to be opened to a very slight extent, the artery separated gently from the vein and nerve, and the ligature passed in a direction from the vein, being careful to avoid the nerve (Fig. 88).

Fig. 88.



1. Anterior belly of the omo-hyoid muscle.
2. Common carotid artery, with descendens noni nerve on its anterior surface.
3. Internal jugular vein.
4. Pneumogastric nerve.
5. Sterno-mastoid muscle drawn aside.

OPERATION.—Below the omo-hyoid muscle in the triangle of necessity.

An incision from two and a half to three inches in length should be made from opposite the cricoid cartilage to a point one-quarter of an inch above the sternum along the inner edge of the sterno-mastoid muscle, dividing the skin. The superficial fascia, platysma, and the layers of the deep fascia should be carefully divided upon the direc-

tor, exposing the sterno-mastoid muscle. Turning the head towards the side operated on, and slightly flexing it, so as to relax the muscles, the sterno-mastoid is drawn to the outer side, and the sterno-hyoid and sterno-thyroid muscles to the inner side. The sheath of the vessels, lying beneath the layers of the deep fascia, which should be divided, is opened carefully, and the ligature passed from the vein, care being taken to avoid the pneumogastric and the descendens noni nerve, which latter here lies somewhat to the inner side (Fig. 88).

In performing the operation above the omo-hyoid muscle, the student should bear in mind the direction which the anterior belly of this muscle takes in passing to its point of insertion on the hyoid bone, and the point at which it crosses the artery. From its point of origin on the upper border of the scapula, it passes forward across the root of the neck, leaving the line of the upper border of the clavicle gradually until it reaches the sterno-mastoid muscle, behind which it becomes tendinous and changes its direction, ascending almost vertically upward to the hyoid bone, forming an obtuse angle. This direction takes it across the artery at a point slightly below the middle; as the ligature should be applied just above its upper border, the middle point of the artery should be ascertained, and the incision made so as to expose this part. This point corresponds to the *lower* border of the larynx, and can, therefore, be easily fixed. The upper part of the artery, just below the point of bifurcation, should not be chosen for the application of the ligature, owing to the position in front, of the facial, lingual, and superior thyroid veins. Attention is also directed to the intimate relation which the internal jugular vein has to the

artery; the large column of blood it carries brings it prominently into the wound, and the extreme thinness of its walls renders it liable to be easily wounded.

In the operation below the omo-hyoid muscle, the relations of the middle thyroid vein, the inferior thyroid artery, and the recurrent laryngeal nerve, with the position of the internal jugular vein across the artery at the root of the neck on the left side, should be borne in mind.

The importance of the sterno-mastoid muscle as a guide to the carotid artery, should not be forgotten. In its entire extent it may be said to be covered and protected by this muscle, being placed well under it in the first part of its course, and gradually approaching its anterior border as it ascends the neck. The muscle is embraced between two layers of the deep cervical fascia, which unite at its anterior border. When the fibres of the muscle are exposed in the operation, it is to be remembered that but one layer of the envelope of the muscle has been divided, and that another lies beneath, separating the muscle from the sheath of the vessels, which must be divided before the sheath is reached.

The External Carotid Artery. SURGICAL ANATOMY.—Owing to the complicated relations of this vessel, and the number of branches given off from it, ligation, except in cases of wounds, is rarely performed. If necessary, a ligature may be applied near its origin or above the posterior belly of the digastric muscle. In the first part of its course, the artery lies in the triangular space formed by the sterno-mastoid behind, the anterior belly of the omo-hyoid below, and the posterior belly of the digastric above. In this space it is crossed by the facial and lingual veins and by the hypoglossal nerve below the tendon of the

digastric muscle. As it ascends it gets beneath the digastric muscle, and passes deeply into the substance of the parotid gland, where it is crossed by the facial nerve (Fig. 87, 8).

Course—From the upper border of the thyroid cartilage upward, forward, and backward to the space between the neck of the condyle of the lower jaw and the external auditory meatus.

Surface markings—Sterno-mastoid muscle and posterior border of the ramus of the lower jaw.

General relations: In front—Skin, superficial fascia, platysma muscle, deep fascia, hypoglossal nerve, facial and lingual veins, digastric and stylo-hyoid muscles.

Behind—Superior laryngeal and glosso-pharyngeal nerves, stylo-glossus and stylo-pharyngeus muscles.

Internally—Hyoid bone and pharynx, ramus of the lower jaw.

Guides—Below, sterno-mastoid muscle; above, posterior belly of the digastric muscle and the parotid gland.

Structures to be avoided—Lingual and facial veins, and hypoglossal nerve.

OPERATION.—At the point of origin of this artery the ligature may be applied by the same plan of operation as that adopted in the ligation of the common carotid artery above the omo-hyoid muscle (Fig. 88). The incision is made from a point opposite the greater cornu of the hyoid bone, downward to the extent of two and one-half to three inches, dividing the skin. The superficial fascia, platysma muscle, and deep fascia are divided on the director, exposing the sheath of the vessel, which is opened, and the ligature is passed from without inward, care being taken to avoid the internal carotid artery which lies behind and somewhat external.

Above the posterior belly of the digastric muscle, the artery is reached by an incision extending from the lobe of the ear to the great cornu of the hyoid bone, dividing the skin. The superficial fascia, platysma, and deep fascia are divided carefully on the director, exposing the parotid gland. The posterior belly of the digastric, with the stylo-hyoid muscle, are found below at the bottom of the wound, and are to be separated from the parotid gland above, when the artery will be exposed before its entrance into the substance of the gland.

In ligating the artery at this point, the student should recall the position of the numerous venous trunks which occupy this region. Some of these are necessarily divided, and give rise to considerable hemorrhage, which complicates the operation. When necessary, these should be ligated with two ligatures, and then divided. If cut before ligation, and the amount of hemorrhage warrants it, a ligature should be applied as in the arteries. In this region, also, there will be found most important structures, vessels, and nerves, which are to be dealt with cautiously.

The Superior Thyroid Artery. SURGICAL ANATOMY.—This vessel is the first branch of the external carotid artery, being given off just above the point of bifurcation (Fig. 87). It lies superficially in the triangle of election at the beginning of its course, and can be reached readily.

Course—From the point of origin below the greater cornu of the hyoid bone upward and inward, then curving downward and forward to the upper part of the thyroid gland.

Surface markings—Sterno-mastoid muscle and greater cornu of the hyoid bone.

General relations—The same in the first part of the artery as those of the external carotid.

Guide—Greater cornu of the hyoid bone.

Structure to be avoided— The superior thyroid vein.

OPERATION.—The incision to be made in ligating this vessel is on the same line, but somewhat internal to that made for exposing the external carotid. The superficial structures are to be divided, when the vessel will be brought into view, as it ascends (Fig. 89).

Fig. 89.

The Lingual Artery. SURGICAL ANATOMY.—This artery is the second branch of the external carotid given off from its anterior surface (Fig. 87, 12).

Course—From the external carotid artery just below the greater cornu of the hyoid bone obliquely upward and inward, horizontally forward parallel to the greater cornu, and then vertically upward to the under surface of the tongue.

Surface marking—Hyoid bone.

General relations. First portion: In front—Skin, superficial fascia, platysma, and deep fascia.

Behind—Middle constrictor muscle.

Above—Hyoid bone.

Below—Thyroid cartilage.

Second portion: In front—Superficial structures, with the digastric and stylo-hyoid muscles and hypoglossal nerve.

Behind—Middle constrictor muscle.

Below—Greater cornu of the hyoid bone.

Above—Muscles of the tongue.

Guides—Posterior belly of the digastric muscle and the hypoglossal nerve.

Structure to be avoided—Hypoglossal nerve.

OPERATION.—A transverse incision is made along the upper border of the hyoid bone from a point in the median line of the neck a little below the symphysis of the lower jaw to near the border of the sterno-mastoid muscle, dividing the skin. The superficial fascia, platysma, and deep fascia should be divided on the director. Seek for the posterior belly of the digastric muscle and hypoglossal nerve. The artery will be found along the upper border of the great cornu of the hyoid bone just as it passes beneath the hyoglossus muscle. If not found at this point, it may be necessary to divide the attachment of the hyoglossus muscle in order to reach the vessel and apply the ligature. Care should be taken to avoid the hypoglossal nerve (Fig. 89).

The Facial Artery. SURGICAL ANATOMY.—This is the third branch given off from the anterior surface of the external carotid artery, and may be ligated as it passes over the border of the lower jaw, at the anterior inferior angle of the masseter muscle (Fig. 87, 9).

Course—From the point of origin a short distance above the cornu of the hyoid bone, obliquely forward and upward to the submaxillary gland, through which it passes, and upward over the body of the lower jaw at the anterior inferior angle of the masseter muscle; forward and upward to the angle of the mouth, upward along the side of the nose, terminating at the inner canthus of the eye.

Surface marking—Masseter muscle.

Relations at the point of ligation: In front—Skin and superficial fascia.

Behind—Body of the lower jaw.

Externally—The masseter muscle and facial vein.

Internally—The depressor anguli oris muscle.

Guide—The anterior inferior angle of the masseter muscle.

Structure to be avoided—The facial vein.

OPERATION.—Fix the position of the anterior inferior angle of the masseter muscle, and make an incision, one inch in length, in the line of the artery, dividing the skin. The superficial fascia and fibres of the platysma muscle being divided on the director, the artery will be exposed with the vein to the outside. The ligature is to be passed, avoiding the vein (Fig. 89).

The Temporal Artery. SURGICAL ANATOMY.—This artery is the smaller of the two terminal branches of the external carotid, and takes its origin in the substance of the parotid gland at a point midway between the neck of the condyle of the lower jaw and the external auditory meatus. Two inches above the root of the zygoma, over which it passes, it divides into the anterior and posterior temporal branches.

Course—From the interspace between the neck of the condyle of the lower jaw and the external meatus, directly upwards over the root of the zygoma.

Surface marking—Root of the zygoma.

General relations: In front—Skin, superficial fascia, attrahens aurem muscle, and dense fascia from over the parotid gland; superficial veins and nerves.

Behind—Zygomatic arch.

Outside—External auditory meatus.

Inside—Origin of masseter muscle.

Guide—Zygomatic arch.

Structures to be avoided—Temporal vein and branches of auriculo-temporal nerve.

OPERATION.—An incision one inch in length and one-third of an inch in front of the tragus should be made in the line of the vessel, dividing the skin. The superficial fascia, attrahens aurem muscle, and parotid fascia are to be divided carefully on the director, and the artery will be found lying on the zygoma. The vein which lies to the outside should be avoided in passing the ligature (Fig. 89).

The Occipital Artery. SURGICAL ANATOMY.—The occipital artery is the first branch of the external carotid arising from the posterior part.

Course—From the point of origin near the lower margin of the digastric muscle obliquely upward across the internal carotid to a point between the transverse process of the atlas and the mastoid process of the temporal bone, then horizontally backward in a groove on the surface of the bone, and vertically upward to the occiput.

Surface marking—Mastoid process of temporal bone.

Relations at point of ligation: In front—Skin, aponeuroses of the sterno-mastoid muscle, splenius, digastric, and trachelo-mastoid muscles.

Behind—Complexus, superior oblique, and rectus posticus major muscles.

Guide—Mastoid process.

Structure to be avoided—Occipital vein.

OPERATION.—The artery can be reached by making an incision one inch and a half in length over its course from the mastoid process of the temporal bone to the external occipital protuberance, dividing the skin. The fascia, aponeuroses of the sterno-mastoid muscle, and the splenius capitis muscle must be divided, when the artery will be exposed, and the ligature applied, avoiding the vein which lies to the outside (Fig. 89).

The Internal Carotid Artery. SURGICAL ANATOMY.—The beginning of the first portion of this vessel is quite superficial, contained, as it is, in the superior carotid triangle, and being on the same plane with, but behind, the external carotid (Fig. 87, 10). As it ascends it approaches the vertebræ lying above on the pre-vertebral structures. Ligation just above the point of bifurcation may therefore be performed. Above the point where it is crossed by the stylo-hyoid and posterior belly of the digastric muscles, its relations are so complicated that any operation performed with a view to apply a ligature will be attended by serious difficulties.

Course—From the point of bifurcation of the common carotid artery opposite the upper border of the thyroid cartilage, vertically upward to the carotid foramen in the petrous portion of the temporal bone.

Surface marking—Sterno-mastoid muscle.

General relations: In front—Skin, superficial fascia, platysma, deep fascia, sterno-mastoid, digastric, and stylo-hyoid muscles; external carotid and occipital arteries; hypoglossal nerve, and parotid gland.

Behind—Rectus anticus major muscle, and superior laryngeal nerve.

Outside—Internal jugular vein and pneumogastric nerve.

Inside—Pharynx, tonsil, and ascending pharyngeal artery.

Guide—Inner edge of sterno-mastoid muscle.

Structures to be avoided—Internal jugular vein, external carotid artery, and pneumogastric nerve.

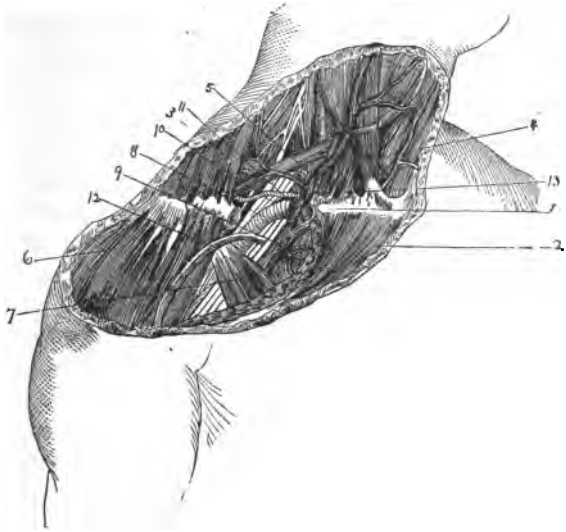
OPERATION.—The operation for ligating the artery just above the point of bifurcation is the same as that performed in ligating the external carotid at this point. The incision should be made along the anterior edge of the sterno-mastoid muscle, somewhat to the outside of that made in securing the external carotid, owing to the position of the internal behind the external carotid.

The Subclavian Artery. SURGICAL ANATOMY.—This vessel, on the right side, arises from the innominate artery behind the sterno-clavicular junction, and ascends obliquely outward to the inner border of the scalenus anticus muscle; outward, behind the muscle, and from the outer border obliquely outward and downward beneath the clavicle to the lower border of the first rib, terminating in the axillary artery (Figs. 90, 91). On the left side it takes origin from the transverse portion of the arch of the aorta, and ascends almost vertically to the inner border of the scalenus anticus muscle, taking then the same course as on the right side. The scalenus anticus muscle therefore divides it into three parts: the first lying to the inner side, the second behind, and the third extending from the outer side to the lower border of the first rib.

Ligation of the first and second parts is very rarely practised; the branches given off from the first part render

the operation extremely hazardous, as well as prevent complete interference with the circulation by means of the

Fig. 90.



The Axillary and Subclavian Arteries.

1. Clavicle cut across.
2. Pectoralis major muscle partially cut away.
3. Trapezius muscle.
4. Sterno-cleido-mastoid.
5. Omo-hyoid.
6. Deltoid.
7. Pectoralis minor.
8. The axillary artery.
9. The axillary vein.
10. The brachial plexus, above and behind.
11. Supra-scapular artery.
12. Cephalic vein passing in inter-space between deltoid and pectoralis major muscles to enter into axillary vein just above upper border of pectoralis minor muscle.
13. External jugular vein.

ligature. If it should become necessary, it can be reached by the same incision as is made in ligating the innominate artery.

The second part lies deeply behind the muscle, and offers no advantage over the third part, which is readily reached.

Fig. 91.

The Subclavian Artery.
1. Subclavian artery.
2. Subclavian vein.
3. First rib.
4. Scalenus anticus muscle, between vein and artery.

The third part has no branches, and is placed in a triangular space formed above by the posterior belly of the omo-hyoid muscle; below by the clavicle, and to the inner side by the sterno-mastoid muscle. The size of this space is increased or diminished by the extent of attachment of the sterno-mastoid and trapezius muscles to the clavicle, the proximity of the posterior belly of the omo-hyoid to the border of the clavicle, and the position of the shoulder, whether depressed or elevated. In this space the artery has important relations with the surrounding structures. The subclavian vein lies beneath the clavicle at this point of its course; occasionally it rises into this space, and is in relation in front. The brachial plexus of nerves lies above and in close relation to the artery; the supra-scapular vessels pass transversely across the space near the margin of the clavicle; the transverse cervical nerves cross its upper angle; the external jugular vein passes down the neck along the posterior border of the sterno-mastoid, and empties into the subclavian vein; it receives superficial veins, which lie in front of the artery.

It is important to note the height to which the artery in

its course rises in the neck. Normally, it may be said to extend to the height of one-half of an inch above the clavicle; occasionally to the extent of an inch and a half, and sometimes its position is on a level with the upper border of the bone. Its relations with regard to the scalenus anticus also vary; it has been found to pass in front or through the fibres of this muscle, and the vein is noted to have passed behind the muscle with the artery.

Course: Right subclavian—From the sterno-clavicular junction to the lower border of the first rib, obliquely upward, then outward and downward.

Left subclavian—From opposite the second dorsal vertebra to the lower border of the first rib almost vertically upward, then outward and downward.

Surface markings—Posterior border of the sterno-mastoid muscle, anterior border of the trapezius muscle, upper border of the clavicle, possibly posterior belly of the omo-hyoid muscle.

Relations at point of ligation. Third portion: In front—Skin, superficial fascia, platysma muscle, deep fascia; external jugular, suprascapular, and transverse cervical veins; branches of cervical plexus of nerves, suprascapular artery, subclavius muscle, and clavicle.

Behind—Middle scalenus muscle.

Above—Brachial plexus of nerves and posterior belly of the omo-hyoid muscle.

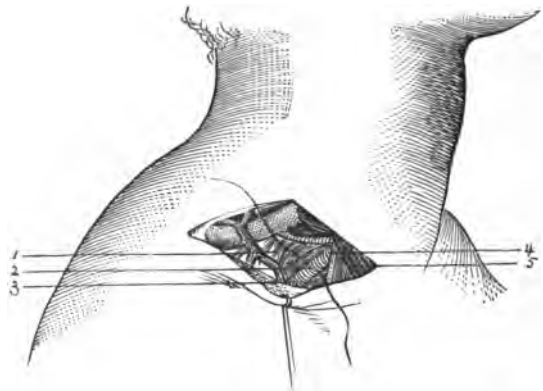
Below—First rib.

Guides in order from without inward—1. Posterior belly of the omo-hyoid. 2. Brachial plexus. 3. Scalenus anticus muscle. 4. Tubercle on first rib.

Structures to be avoided—External jugular vein, suprascapular artery, brachial plexus of nerves, subclavian vein.

OPERATION.—Depressing the shoulder, so as to enlarge the subclavian triangle, an incision extending along the upper border of the clavicle from the posterior border of the sterno-mastoid to the anterior border of the trapezius should be made, dividing the skin. The superficial fascia and platysma should be divided on the director. The external jugular vein, at the inner side of the wound, should be drawn aside; if necessary to divide it, two ligatures should be applied, and the vein cut between. The borders of the sterno-mastoid and trapezius may require division to give space. Avoid the suprascapular artery,

Fig. 92.



1. Brachial plexus of nerves.
2. Subclavian artery.
3. First rib.
4. Scalenus anticus muscle.
5. Posterior border of sterno mastoid muscle.

separate the layers of deep fascia cautiously with the finger, grooved director, or handle of the knife, and seek for the omo-hyoid muscle; avoid the brachial plexus

above, and still further separate the fascia and seek for the scalenus anticus muscle, and trace it to its insertion in the tubercle on the first rib—to its outer side the artery crosses the rib, where it can be felt. Pass the ligature carefully from below upward (Fig. 92).

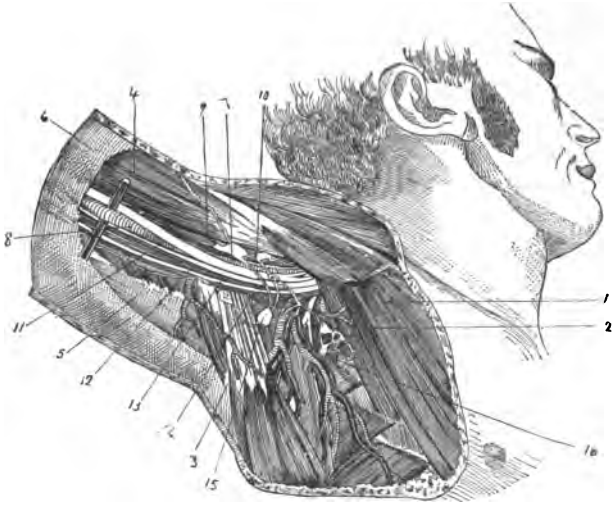
The Axillary Artery. SURGICAL ANATOMY.—The axillary is a continuation of the subclavian, beginning at the lower border of the first rib, passing downward through the axillary space and terminating at the lower borders of the latissimus dorsi and teres major muscles in the brachial (Figs. 90, 93).

The axillary space, or axilla, through which the artery passes, is a conical-shaped cavity placed between the side of the chest above and the inner side of the arm. Its boundaries are formed by the pectoralis major and minor in front, the subscapularis, the latissimus dorsi and the teres major behind, the four upper ribs, intercostal muscles and part of the serratus magnus muscle on the inside, and the humerus, coraco-brachialis, and biceps muscles on the outside. This space contains important structures, in close relation; the axillary vessels and brachial plexus of nerves with their branches, also branches of the intercostal nerves with lymphatic glands (ten or twelve in number), all held together by a quantity of fat and areolar tissue. A prolongation of the costo-coracoid membrane surrounds, to a greater or less extent, the vessels and nerves, forming a sheath for them.

The course of the artery through this space varies according to the position of the arm. When the arm is placed in contact with the side of the chest, the artery is gently curved, the convexity looking upward and outward.

With the arm at right angles to the body, it passes in a direct line, and the arm being extended it assumes a curve,

Fig. 93.



Axillary Artery below Pectoralis Minor Muscle.

1. Pectoralis major muscle drawn upward.
2. Pectoralis minor.
3. Latissimus dorsi and teres major muscles.
4. Biceps muscle.
5. Triceps muscle.
6. Deep fascia of the arm.
7. Axillary artery.
8. Brachial artery.
9. Coraco-brachialis muscle.
10. Musculo-cutaneous nerve.
11. Median nerve.
12. Internal cutaneous nerve.
13. Ulnar nerve.
14. Axillary vein.
15. Lymphatic gland.
16. Subscapular and inferior thoracic vessels.

the convexity of which looks downward. It passes from the apex to the base of the axilla nearer the anterior than the posterior wall, and is divided into three parts by the pectoralis minor muscle, the first portion extending from the lower border of the first rib to the upper border of the muscle, the second lying behind it, and the third terminating at the insertion of the latissimus dorsi and teres major muscles. Ligation can be performed in either the first or third portion; the second portion is quite inaccessible, on account of its position behind the pectoralis minor muscle, and its relations complicated by being embraced by the roots of the median nerve which arise from the inner and outer cord of the plexus, and unite either in front or on the outside of the artery. When selection is permitted, the third part is chosen as easier of access and freer from complications.

LIGATION IN THE FIRST PORTION. *Course*—From lower border of first rib to upper border of the pectoralis minor muscle.

Surface marking—Lower border of clavicle.

Relations at point of ligation: In front—Pectoralis major muscle, costo-coracoid membrane, cephalic vein.

Behind—First intercostal space and muscle, second serration of serratus magnus muscle, posterior thoracic nerve.

Inside—Axillary vein.

Outside—Brachial plexus of nerves.

Guides—Pectoralis major muscle, deeper, pectoralis minor muscle, and costo-coracoid membrane.

Structures to be avoided—Superficially, cephalic vein and thoracico-acromialis artery; deeper, axillary vein and brachial plexus of nerves.

OPERATION.—The arm and the shoulder being drawn back, an incision three inches in length, one-half of an inch below the clavicle and parallel to it, extending from the sternum to the edge of the deltoid muscle, should be made, dividing the skin. The superficial and deep fascia should be divided on the director, exposing the pectoralis major muscle. Divide the fibres of the clavicular portion of the muscle to the same extent as the external incision, and carefully incise the areolar tissue which lies below. Seek the upper border of the pectoralis minor muscle, and cautiously open the costo-coracoid membrane. Relax the pectoralis minor muscle by bringing the arm to the side, and separate with the grooved director the artery carefully from the vein and other structures, and pass the ligature needle from within outward, carefully avoiding the vein (Fig. 94).

The artery can be reached, if necessary, in the second part by extending this incision downward.

LIGATION IN THE THIRD PORTION. *Course*—From the lower border of the pectoralis minor muscle to the lower borders of the latissimus dorsi and teres major muscles (Fig. 93).

Surface markings—Borders of the axilla, head of the humerus, inner border of the coraco-brachialis muscle.

Relations at point of ligation: In front—Skin, fascia, and pectoralis major muscle.

Behind—Subscapularis, latissimus dorsi and teres major muscles, musculo-spiral and circumflex nerves.

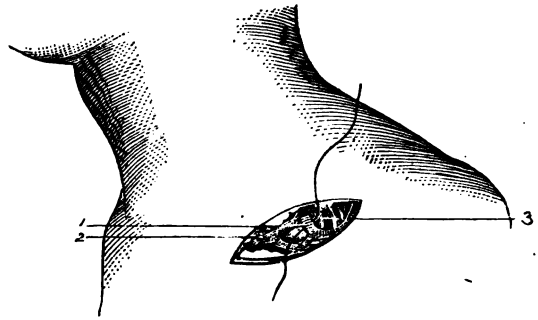
Inside—Axillary vein, ulnar and internal cutaneous nerves.

Outside—Coraco-brachialis muscle, median and musculo-cutaneous nerves.

Guide—Coraco-brachialis muscle.

Structures to be avoided—Axillary vein, median and ulnar nerves.

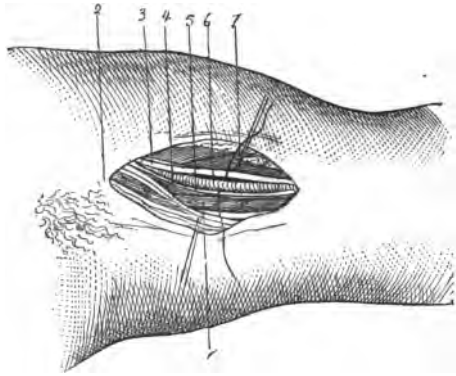
Fig. 94.



1. Axillary artery.
2. Axillary vein.
3. Brachial plexus of nerves.

OPERATION.—Placing the arm at right angles to the body, make an incision two and one-half inches in length over the course of the artery, at the point of junction of the anterior and middle thirds of the axilla, dividing the skin. Divide the fascia carefully on the grooved director, separate the areolar tissue with the finger or handle of the knife, and seek the axillary vein to the inside and median nerve to the outside. Flex the arm so as to relax the vein and nerve, isolate the artery carefully, and pass the ligature needle from within outward (Fig. 95). Note a muscular slip from the latissimus dorsi muscle which occasionally crosses the artery at this point, which may mislead. The transverse direction of its fibres can be recognized.

Fig. 95.



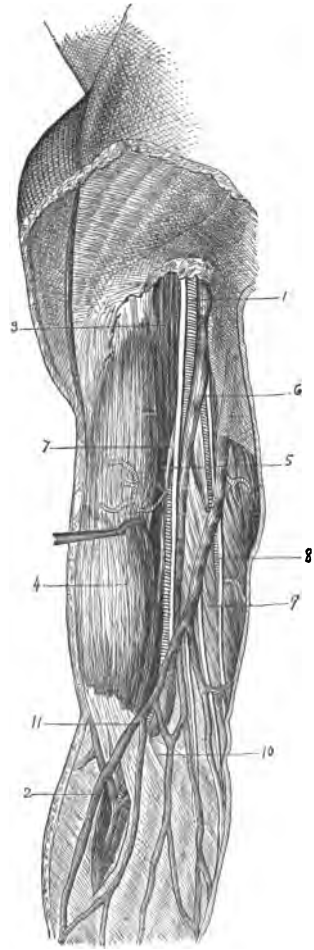
1. Axillary vein.
2. Axilla.
3. Pneumogastric nerve.
4. Ulnar nerve—drawn aside.
5. Internal cutaneous nerve.
6. Axillary artery.
7. Inner border of coraco-brachialis muscle.

The Brachial Artery. SURGICAL ANATOMY.—This artery begins at the lower border of the tendons of the latissimus dorsi and teres major muscles, and passes down on the inner and anterior surface of the arm, terminating about one-half of an inch below the bend of the elbow in the radial and ulnar arteries (Fig. 96). A line drawn from the point of junction of the anterior and middle thirds of the axilla to a point midway between the condyles, will indicate its course. As it descends it winds around the bone, passing from the inner to the anterior surface. For the purposes of ligation, it may be divided conveniently into two parts, that lying above the point at which the median nerve crosses it, which may be designated as the

middle of the vessel, and that below this point. In the upper part, the nerve lies to the outer side of the artery in close contact; as it descends it passes very obliquely in front, and occasionally behind, and takes a position to the inner side. The artery also presents a number of peculiarities as to course, point of bifurcation, and muscular relations which should be considered by the student.

Its course down the arm may be varied by a departure from the inner border of the biceps muscle to the inner condyle of the humerus, and then to the bend of the elbow, passing through the pronator radii teres muscle.

Fig. 96.



The Brachial Artery

1, 2. The brachial artery.
3. Coraco-brachialis muscle.
4. Biceps muscle.
5. Median nerve, crossing the artery.
6, 7. Venæ comites.
8. Inferior profunda artery.
9. Ulnar nerve.
10. Bicipital fascia, beneath which the artery passes.
11. Median basilic vein separated from the artery by bicipital fascia.

Irregularity with regard to the point of bifurcation is of rather frequent occurrence; it occurs more frequently in the upper than in the middle or lower part of the arm—in three out of four cases it takes place as a high division of the radial, which arises from the inner surface of the brachial, and passes down the arm parallel with the main trunk to the elbow, where it crosses the artery to the outside. In these cases, two large vessels would be found, which should be carefully examined, in order to decide to which one the ligature should be applied.

Occasionally it is found that muscular layers passing between the coraco-brachialis and triceps muscles, and between the other muscles, have covered the artery for some distance in its course; these must be divided, in order to reach the vessel.

Course—From the lower margin of the teres major muscle to one-half of an inch below the bend of the elbow. A line drawn from the point of junction of the anterior and middle thirds of the axilla to a point midway between the condyles, will indicate its course.

Surface markings—Inner border of the coraco-brachialis and biceps muscles.

General relations: In front—Skin and fascia, median nerve, and median basilic vein.

Behind—Triceps, coraco-brachialis, and brachialis anticus muscles; musculo-spiral nerve, and superior profunda artery.

Inside—Internal cutaneous, ulnar, and median nerves.

Outside—Median nerve, coraco-brachialis and biceps muscles.

Guides—Inner border of coraco-brachialis and biceps muscles.

Structures to be avoided— Median nerve, possibly ulnar nerve, and superior profunda artery; internal cutaneous nerve and basilic vein.

OPERATION. — Above the point at which the median nerve crosses the artery.

The arm being drawn from the side, and the hand supinated, an incision from two to three inches in length should be made along the inner border of the coraco-brachialis muscle, dividing the skin. The superficial and deep fasciæ should be divided carefully on the director, care being taken to avoid the internal cutaneous nerve. The artery, accompanied by venæ comites, will be found lying along the border of the coraco-brachialis muscle; the internal cutaneous and ulnar nerves and basilic vein being to the inner, and the median to the outer side. Separate the venæ comites, and pass the ligature-needle from within outward, avoiding the vein.

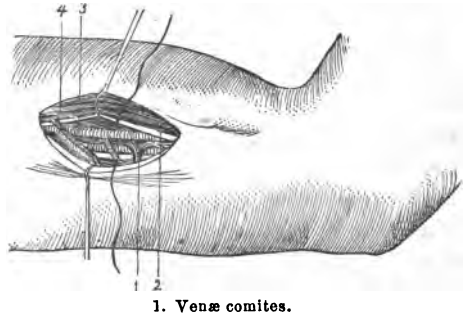
OPERATION. — Below the point at which the median nerve crosses the artery.

The arm being in the same position as in the operation just described, an incision from two to three inches is made directly over the inner border of the biceps muscle, dividing the skin. The superficial and deep fasciæ are very carefully divided, in order to avoid the basilic vein, which at this point is superficial. The median nerve is now seen as a large white cord lying to the inside of the artery. Flex the arm so as to relax the biceps and median nerve, and separate the venæ comites from the artery. Pass the ligature-needle from within outward (Fig. 97).

In this operation the attention of the student is directed to the position of the artery, median nerve, and ulnar nerve, and their relation to each other. The artery, at this point, lies in very close contact with the border of

the biceps, the median nerve separated slightly to the inner side, and the ulnar nerve removed some distance from the median, and passing inward and backward. If the incision is made too far from the inner border of the biceps muscle, the ulnar nerve may be mistaken for the median, and thus confusion arise. This error can be avoided by keeping near to the border of the biceps muscle, and bearing in mind the order of relation from without inward, which is as follows: inner edge of biceps —artery in close contact; median nerve, slightly separated from artery; ulnar, separated to some distance from median nerve (Fig. 96).

Fig. 97.



1. Venæ comites.
2. Median nerve.
3. Brachial artery.
4. Biceps muscle.

The Brachial Artery at the Bend of the Elbow. SURGICAL ANATOMY. — At this point the artery occupies a position beneath the tendon of the biceps in a triangular space formed by the supinator longus muscle externally, the pronator radii teres internally, the floor being formed by the brachialis anticus and supinator brevis muscles.

Course—Obliquely across the bend of the elbow from within outward.

Surface markings—Pronator radii teres and supinator longus.

Relations: In front—Skin, fascia, median basilic vein, and bicipital fascia.

Behind—Brachialis anticus muscle.

Inside—Median nerve.

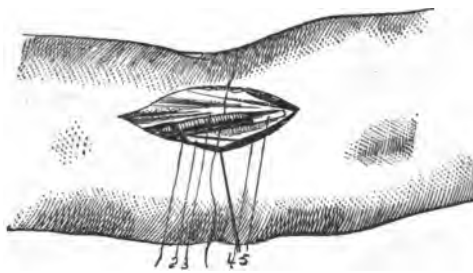
Outside—Supinator longus muscle.

Guide—Inner edge of tendon of biceps muscle.

Structures to be avoided—Median basilic vein; median nerve.

OPERATION.—Make an incision two and a half inches in length along the inner edge of the biceps tendon, the

Fig. 98.

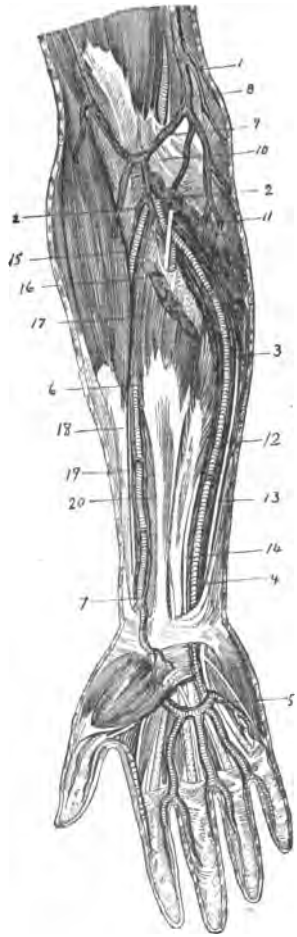


1. Brachial artery.
2. Median nerve.
3. Tendon of biceps muscle.
4. Pronator radii teres muscle.
5. Deep fascia.

arm being extended and the hand supine, dividing the skin. Dividing the superficial fascia carefully, so as to avoid wounding the superficial veins, the bicipital fascia is

exposed. Incise this and seek for the artery, surrounded by the venæ comites, beneath and lying between the tendon of the biceps muscle on the outside and the median nerve on the inside. Pass the ligature-needle from the median nerve (Fig. 98).

Fig. 99.



The Radial and Ulnar Arteries.

1. Brachial artery.
2, 2. Radial and ulnar arteries at point of bifurcation.
3. Ulnar artery, middle third.
4. Ulnar artery, lower third.
5. Superficial palmar arch.
6. Radial artery, middle third.
7. Radial artery, lower third.
8. Median nerve.
9. Median basilic vein.
10. Bicipital fascia.
11. Median nerve crossing ulnar artery.
12. Ulnar nerve.
13. Tendon and muscle of flexor carpi ulnaris.
14. Inner tendon of the flexor sublimis digitorum.
15. Supinator longus muscle.
16. Pronator radii teres muscle cut through.
17. Superficial flexor muscles cut through, showing ulnar artery and median nerve.
18. Beginning of tendon of supinator longus muscle.
19. Radial nerve.
20. Venæ comites.

The Radial Artery. SURGICAL ANATOMY.—The radial artery, the smaller of the two vessels into which the brachial divides, passes from its

point of origin, opposite the coronoid process of the ulna, downward and outward along the radial side of the forearm to the wrist. In its course it passes from the inside of the radius above to the front of the bone below. A ligature may be applied at any part of its course in the upper, middle, or lower third (Fig. 99).

Course—A line drawn from the middle of the bend of the elbow to the front of the styloid process will represent its course.

Surface marking—Inner border of the muscle and tendon of the supinator longus.

General relations: In front—Skin, superficial and deep fasciæ, supinator longus muscle.

Behind—Tendon of biceps muscle, supinator brevis, pronator radii teres, flexor sublimis digitorum, flexor longus pollicis, pronator quadratus muscles, and the radius.

Inside—Pronator radii teres muscle, flexor carpi radialis muscle, and tendon.

Outside—Supinator muscle and tendon.

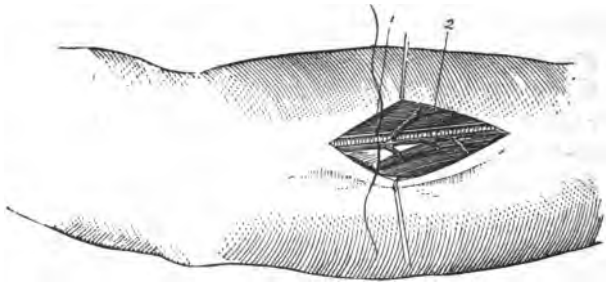
Guide—Supinator longus muscle and tendon.

Structures to be avoided—Median vein and radial nerve.

OPERATION: *In the upper third.*—An incision, from two to three inches in length, dividing the skin and carefully avoiding the median vein, is made from the bend of the elbow obliquely downward and outward in the groove which marks the line of separation between the supinator longus and pronator radii teres muscles. The superficial and deep fasciæ are divided on the director. Flexing the arm slightly, so as to relax the muscles, the supinator longus is drawn aside, and the artery, in its sheath with the venæ comites, will be exposed, the radial nerve lying to

the outside. Separating the venæ comites, the ligature needle is passed from without inward (Fig. 100).

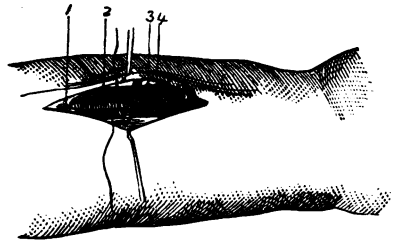
Fig. 100.



1. Supinator longus muscle.
2. Radial artery.

In the middle third.—The artery can be exposed by an incision two inches in length along the inner border of the supinator longus muscle, dividing the skin. The fasciæ being divided, the artery is found, with the radial nerve in close contact on the outside. Pass the ligature needle from the nerve.

Fig. 101.



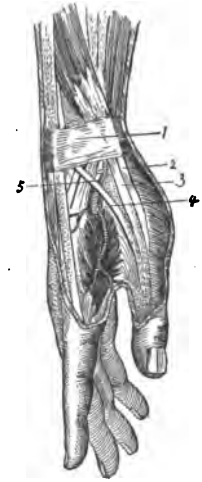
1. Deep fascia.
2, 4. Venæ comites.
3. Artery.

In the lower third.—At this point the artery lies superficial between the tendons of the supinator longus and flexor carpi radialis, the nerve being

some distance to the outside, leaving the artery about three inches above the wrist. Fix the position of the tendon of the flexor carpi radialis muscle by manipulating the hand, and make an incision one inch and a half along its external border, dividing the skin. Divide the fasciæ on the director, and thus expose the sheath of the vessel. Open the sheath, separate the artery from the venæ comites, and pass the ligature needle from without inward (Fig. 101).

On the Outer Side of the Wrist. SURGICAL ANATOMY.—The artery, as it crosses to the outer side of the wrist to pass into the hand, lies beneath the extensor tendons of the thumb, in a space known as the "snuff-box" (Fig. 102). Here it can be ligated by making an incision, which divides the skin, one inch and a quarter in length, beginning opposite the styloid process of the radius and terminating at the first interosseous space. Dividing the fasciæ on the director, seek the tendon of the extensor secundi internodii pollicis muscle, which crosses the artery just before it passes into the palm of the hand, and furnishes a guide to the vessel. Apply the ligature to the artery on the ulnar side of the tendon, avoid-

Fig. 102.



Radial Artery on the outer side of the Wrist.

1. Posterior annular ligament of the carpus.
2. Tendon of extensor ossis metacarpi pollicis.
3. Tendon of extensor primi internodii pollicis.
4. Tendon of the extensor secundi internodii pollicis
5. Radial artery.

ing the veins and a small branch of the musculo-cutaneous nerve which accompanies it.

The Ulnar Artery. SURGICAL ANATOMY.—This vessel, the larger of the two terminal branches of the brachial artery, begins at the point of bifurcation opposite the coronoid process of the ulna, and crosses obliquely to the inner side of the forearm, which it reaches about the middle, then descends along the ulnar border to the wrist, terminating in the superficial palmar arch. A line drawn from the internal condyle of the humerus to the outer side of the pisiform bone, will indicate its course in the lower half. Ligation in the upper portion is rarely performed, owing to the position of the vessel beneath the superficial flexor muscles, which must be divided in order to apply the ligature. In the middle part it is slightly covered by the tendons of the flexor carpi ulnaris and the inner tendon of the flexor sublimis digitorum. In the lower part it is superficial. The median nerve crosses it obliquely just below its point of origin, while the ulnar nerve comes into close relation with it at the lower part of the upper half (Fig. 99).

Course—From the bend of the elbow to the radial side of the pisiform bone.

Surface marking—Muscle and tendon of the flexor carpi ulnaris.

General relations: In front: Upper half—Superficial flexor muscles and median nerve.

Lower half—Superficial and deep fasciæ.

Behind—Brachialis anticus and flexor profundus digitorum muscles.

Inside—Flexor carpi ulnaris muscle and, in lower two-thirds, ulnar nerve.

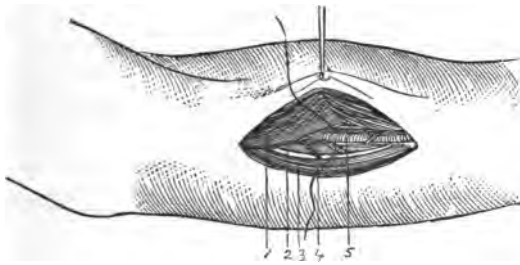
Outside—Muscle and tendons of the flexor sublimis digitorum.

Guide—Muscle and tendon of the flexor carpi ulnaris.

Structures to be avoided—Ulnar nerve and venæ comites in upper half; median nerve.

OPERATION: *In upper half.*—An incision should be made starting two and one-half inches below the internal condyle of the humerus, and one-quarter of the width of the arm from the inner edge, extending downward to the extent of three inches, dividing the skin. The fasciæ being divided, seek the white, pearly aponeurotic line marking the septum between the flexor carpi ulnaris muscle on the inside, and the flexor sublimis digitorum on the outside. Incise this septum to the same extent as the inci-

Fig. 103.



1. Flexor sublimis muscle.
2. Ulnar nerve.
3. Flexor profundus muscle.
4. Venæ comites.
5. Ulnar artery.

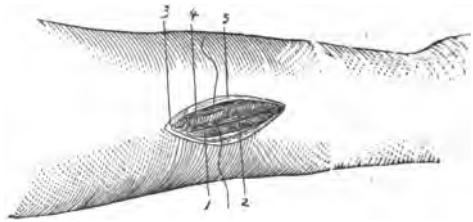
sion through the skin and fasciæ. Flex the arm, and separate with the finger the superficial muscles from the flexor profundus digitorum. Seek the artery lying on this

muscle with the ulnar nerve to the inside. Pass the ligature-needle from the nerve (Fig. 103).

In ligating the vessel at this point the student should take especial care in seeking for the septum which separates the flexor carpi ulnaris from the flexor sublimis digitorum muscle, and which is to be divided in preference to the muscular substance. It will be recognized as a white, glistening membrane, the fibres of which are parallel with the fibres of the muscles.

In middle of the forearm.—The artery can be reached by an incision three inches in length along the external border of the flexor carpi ulnaris, dividing the skin. The fasciæ being divided, the flexor carpi ulnaris and the inner tendon of the flexor sublimis digitorum should be separated, exposing the artery with the ulnar nerve to the

Fig. 104.



1. Flexor carpi ulnaris muscle.
2. Venæ comites.
3. The integuments.
4. Ulnar artery.
5. Deep fascia.

inside in close relation. Pass the ligature-needle from the nerve, avoiding the venæ comites.

In lower half.—An incision two inches in length is made along the outer edge of the tendon of the flexor carpi ulnaris muscle *three-quarters of an inch from the ulnar border* of the limb, dividing the skin. Divide the fasciæ on the director, and, slightly flexing the hand, seek the artery covered by the tendon of the flexor carpi ulnaris and inner tendon of the flexor sublimis digitorum muscle. Separate the venæ comites, and pass the ligature from within outward (Fig. 104).

In this operation the student is cautioned against making the incision too near the ulnar border of the limb.

The Abdominal Aorta. SURGICAL ANATOMY.—The abdominal portion of the aorta is the continuation of the thoracic portion, beginning at the opening in the diaphragm opposite the body of the last dorsal vertebra, and descending on the left side of the vertebræ, terminates on the left side of the fourth lumbar vertebra in the two common iliac arteries. Between the point of origin of the inferior mesenteric artery, a large branch, and the bifurcation of the aorta into the common iliac arteries, there are given off from the posterior surface several small branches, four lumbar from each side, and the sacra media. This portion of the vessel, therefore, presents itself as best adapted for the application of the ligature, as well on this account as on account of its position rendering it easier of access.

Course—From the front of the body of the last dorsal vertebra downward on the left side of the vertebral column to the left side of the body of the fourth lumbar vertebra at the point of bifurcation.

Surface marking—The linea alba.

Relations at point of ligation: In front—The structures forming the abdominal wall, transverse colon, omentum, and mesentery; convolutions of the small intestines, peritoneum.

Behind—Left lumbar veins and vertebræ.

Right side—Inferior vena cava.

Left side—Sympathetic nerve.

Guide—Vertebral column.

Structures to be avoided—Inferior vena cava, sympathetic nerve.

OPERATION.—The vessel can be reached by two methods of operation.

1. By an incision three inches in length through the skin, beginning one and a half inch above umbilicus in the linea alba. Carrying the incision around umbilicus, divide the structures on the director until the peritoneum is reached; incise this on the director, thus opening the abdominal cavity. Raise the omentum, and push the intestines to the right side. Seek the aorta on the left side of the lumbar vertebræ, and carefully tear through the peritoneum covering the vessel. Pass the ligature from the right to the left, avoiding the vena cava.

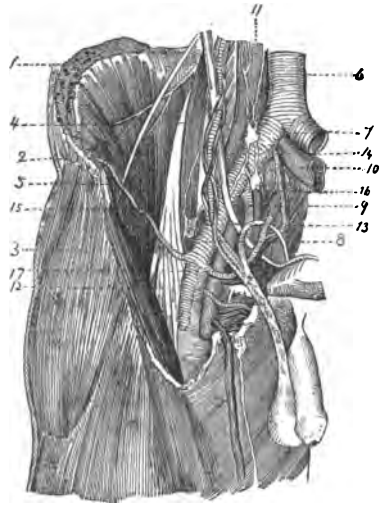
2. An incision should be made on the left side of the body from the end of the eleventh rib to the crest of the ilium, dividing the common integuments. The layers of muscles, external and internal, oblique and transversalis, and transversalis fascia, should be carefully divided on the director. Cautiously push off the posterior layer of the peritoneum until the aorta is uncovered, and pass the ligature as in the first method.

The advantage this method has over the first, is in preserving the integrity of the peritoneum. On the other

hand, the operation by the second plan involves the wounding of the muscular structures, and separation, to some extent, of the peritoneum from the underlying structures.

The Common Iliac Artery. SURGICAL ANATOMY.—The common iliac arteries, terminal branches of the aorta, begin at the point of bifurcation on the left side of the body of the fourth lumbar vertebra, and pass downward and outward to the margin of the pelvis. Oppo-

Fig. 105.



1. Section of the muscles of the abdomen at their insertion into crest of the ilium.
2. Superior spinous process of the ilium.
3. Fascia lata of the thigh.
4. Psoas muscle.
5. Iliacus internus muscle.
6. Aorta.
7. Right common iliac artery.
8. External iliac artery.
9. Internal iliac artery.
10. Iliac vein.
11. Inferior vena cava.
12. Anterior crural nerve.
13. Lymphatic glands.
14. Spermatic vessels.
15. Circumflex iliac artery.
16. The ureter.
17. The epigastric artery.

The Common, External, and Internal Iliac Arteries.

site the intervertebral substance, between the last lumbar vertebra and the sacrum, they divide into the external and internal iliac arteries. The point of bifurcation of the

aorta corresponds to a point to the left of the umbilicus, and on a level with a line passing between the highest points on the crests of the ilia (Fig. 105).

It is to be noted that these vessels lie beneath the peritoneum, and that the relation of the vein on the right and left side differs, being behind and *external* on the right side, and behind and *internal* on the left. High up, the left vein passes behind the right common iliac artery to join the right vein in forming the inferior vena cava. Peculiarities with regard to point of origin, point of division, and relative length are frequently observed, and should be borne in mind.

Course—From bifurcation of aorta on left side of body of fourth lumbar vertebra, downward and outward to opposite the intervertebral substance between last lumbar vertebra and sacrum. A line drawn from the left side of the umbilicus to the middle of Poupart's ligament indicates the course. Length of the vessel, two inches.

Relations at point of ligation: Right common iliac artery: In front—Peritoneum, ileum, branches of sympathetic nerve; at the point of bifurcation into the external and internal iliac arteries, it is crossed by the ureter.

Behind—The two common iliac veins.

Outside—Inferior vena cava, right common iliac vein; psoas magnus muscle.

Left common iliac artery: In front—Peritoneum, branches of sympathetic nerve, rectum, superior hemorrhoidal artery; at bifurcation, crossed by left ureter.

Behind—Left common iliac vein.

Inside—Left common iliac vein.

Outside—Psoas magnus muscle.

Guide—Sacro-iliac articulation.

Structures to be avoided—Common iliac veins, ureters, sympathetic nerve, inferior vena cava, peritoneum.

OPERATION.—An incision, in a direction outward to the anterior superior spine of the ilium, from six to eight inches in length, should be made two inches above and parallel to Poupart's ligament, beginning at the junction of the inner and middle third of the space between the symphysis pubis and the anterior superior spine of the ilium, dividing the skin. The superficial and deep fasciæ, tendon of the external oblique muscle, the internal oblique and transversalis muscles are to be carefully divided on the director, layer after layer, until the transversalis fascia is exposed. The edges of the wound should be separated by spatulas, the transversalis fascia gently raised and scratched through, making an opening, into which the point of the director can be introduced. Making sure, by careful examination, that the director is *between* the fascia and the peritoneum, and not beneath the latter, the fascia should be divided. The peritoneum is now gently pushed off to a sufficient extent to enable the artery to be brought into view at the sacro-iliac junction. Opening carefully, with the finger nail or with the point of the director, the sheath of the vessel, and separating the vein from the artery, the ligature is to be passed from the latter.

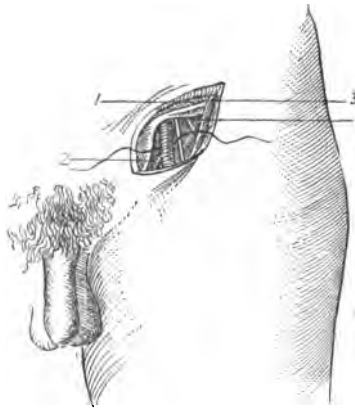
The External Iliac Artery. SURGICAL ANATOMY.—The external iliac artery is the larger of the two terminal branches of the common iliac, and passes from the point of bifurcation obliquely downward and outward along the inner border of the psoas magnus muscle to the crural arch. A line drawn from a point to the left of the umbilicus, to a point midway between the anterior superior

spinous process and the symphysis pubis, will indicate its course (Fig. 105).

Course—Obliquely downward and outward across the pelvic cavity to the crural arch.

Relations at the point of ligation: In front—Peritoneum, intestines, iliac fascia, spermatic vessels, genito-crural nerve, circumflex iliac vein, lymphatic vessels and glands.

Fig. 106.



1. The internal oblique and transversalis muscles.
2. The external iliac artery.
3. The external oblique muscle.
4. The peritoneum.

Behind — External iliac vein.

Inside — External iliac vein and the vas deferens.

Outside—Psoas magnus muscle, iliac fascia.

Guide—Inner border of the psoas magnus muscle.

Structures to be avoided—External iliac vein, genito-crural nerve, peritoneum.

OPERATION. — This artery can be exposed by the same plan of operation as that employed in ligation of the common iliac artery (page 145). The incision need be but four inches in length, and not so far removed from the line of Poupart's ligament (Fig. 106).

The Internal Iliac Artery. SURGICAL ANATOMY.—The internal iliac artery, the smaller of the terminal

branches of the common iliac, is a short branch measuring about an inch and a half in length (Fig. 105). It presents peculiarities, as to length and point of division, which should be noted.

Course—From the point of bifurcation of the common iliacs, downward to the upper margin of the great sacro-sciatic foramen.

General relations: In front—Peritoneum, ureter.

Behind—Internal iliac vein, lumbo-sacral nerve, pyriformis muscle.

Outside—Psoas magnus muscle.

Guide—Inner border of the psoas magnus muscle.

Structures to be avoided—Internal iliac vein and ureter, peritoneum.

OPERATION.—This vessel can be surrounded by a ligature by the same method as that described for tying the external iliac artery (Fig. 106).

In performing operations for the ligation of the iliac arteries, careful attention should be given to the relations of the large venous trunks which accompany them. These vessels lie in close contact with the arteries, their walls are delicate and thin, and they receive numerous branches from the different parts of the pelvic cavity. Great care should be exercised in using instruments to displace them or to separate them from the arteries. The position of the ureters should also be carefully considered. Being closely united to the peritoneum, they are usually lifted with that structure when it is detached to expose the vessels. In persons of advanced age, the peritoneum is frequently found quite adherent to the underlying tissues, and therefore difficult to separate. In these cases, unless great caution be observed, this membrane may be lacerated.

The Gluteal Artery. SURGICAL ANATOMY. — The gluteal artery, the largest branch of the internal iliac, is given off from the posterior trunk, and passes out of the pelvic cavity through the great sacro-sciatic foramen above the upper border of the pyriformis muscle.

Course—A line drawn from the posterior superior spine of the ilium to the top of the great trochanter, indicates the course of the artery after its emergence from the pelvic cavity.

General relations: Outside—Skin, superficial and deep fasciæ, glutæus maximus muscle.

Inside—Glutæus minimus muscle.

Above—Glutæus medius muscle.

Below—Pyriformis muscle.

Guides—Pyriformis and glutæus medius muscles.

Structures to be avoided—Gluteal vein and superior gluteal nerve.

OPERATION.—The patient being placed on his abdomen, an incision, five inches in length, is made over the course of the artery, dividing the skin. The superficial and deep fasciæ are divided on the director, exposing the glutæus maximus muscle. The fibres of this muscle should be separated, and the artery sought for as it emerges from the pelvic cavity above the upper border of the pyriformis muscle, and the ligature applied, carefully avoiding the veins and nerve.

The Sciatic Artery. SURGICAL ANATOMY. — The sciatic artery is the larger of the two terminal branches of the anterior trunk of the internal iliac, and escapes from the pelvic cavity through the lower part of the great sacro-sciatic foramen.

Course—After emerging from the pelvic cavity through the lower part of the great sacro-sciatic foramen between the pyriformis and coccygeus muscles, it passes downward in the interval between the trochanter major and tuberosity of the ischium. The point of exit from the pelvic cavity is indicated by the centre of a line drawn from the posterior superior spinous process of the ilium to the tuberosity of the ischium.

Relations: Outside—Skin, superficial and deep fasciæ, and glutæus maximus muscle.

Inside—Gemellus superior and obturator internus muscles.

Above—Pyriformis muscle.

Below—Coccygeus muscle.

Guide—Coccygeus muscle, and lower border of the pyriformis muscle.

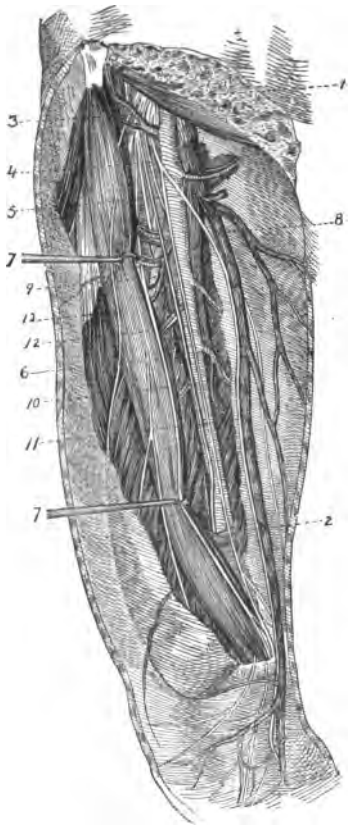
Structures to be avoided—Internal pudic artery, sciatic nerve and vein.

OPERATION.—The patient being placed upon the abdomen, an incision three inches in length is made over the point of exit of the artery from the pelvic cavity, in the line given to indicate this point, dividing the skin. The superficial and deep fasciæ should be divided, exposing the fibres of the glutæus maximus muscle. Separate the fibres of this muscle, and seek the artery as it appears between the coccygeus and pyriformis muscles. Pass the ligature, carefully avoiding the nerve and vein.

The Internal Pudic Artery. SURGICAL ANATOMY.—This artery is the smaller of the two terminal branches of the anterior trunk of the internal iliac. As it escapes from the pelvic cavity by the same opening as the sciatic

artery, its course and relations at the point of ligation are essentially the same, and it may be secured by a similar plan of operation.

Fig. 107.



The Femoral Artery.

The Femoral Artery. SURGICAL ANATOMY.—The femoral artery is the continuation of the external iliac, and passes downward on the anterior and inner aspect of the thigh from the crural arch to the junction of the middle with the lower third of the thigh, where it enters an opening in the adductor magnus muscle and becomes

1. Poupart's ligament.
2. Aponeurosis forming Hunter's canal.
3. Anterior crural nerve.
4. Femoral artery.
5. Femoral vein.
6. Long saphenous nerve.
7, 7. Sartorius muscle, drawn to the outside.
8. Internal saphenous vein.
9. Profunda femoris artery.
10. Branch of anterior crural nerve, lying in front of the femoral sheath.
11. Another branch which passes across the vessels to join the internal saphenous vein.
12, 12. Musculo-cutaneous branches.

the popliteal (Fig. 107). The upper third of the vessel is superficial, and occupies a triangular space called "Scarpa's triangle." This triangle corresponds to the depression immediately below the fold of the groin, and is bounded by the sartorius muscle on the outside, the adductor longus muscle on the inside, and Poupart's ligament above. The floor is formed by the iliacus, psoas, pectineus, adductor longus, and a part of the adductor brevis muscles, passing in order from without inward.

The femoral vessels bisect this triangle as they pass from the middle of the base to the apex. Above, the artery lies on the inner border of the psoas magnus muscle, which separates it from the capsular ligament of the hip-joint. The artery and vein are inclosed in a strong fibrous sheath, the crural sheath, formed by the transversalis and iliac fasciæ—the artery, to the outside, and the vein, to the inside, separated by a septum.

The anterior crural nerve lies to the outside of the common sheath, to the distance of about one-half of an inch. The femoral vein above lies to the inner side of the artery; a short distance below the origin of the profunda femoris it passes behind the artery, and in the lower third it is placed on the outside.

The course the vein takes should be remembered, and its relations to the artery at the various parts of its course —inside, behind, and outside, in order, from above downward.

The internal saphenous nerve, the largest branch of the anterior crural, comes into immediate relation with the artery about the middle third, as it passes beneath the sartorius muscle; as it descends it gradually gets in front of the artery, crossing it as it enters Hunter's canal, and pass-

ing to the inside of the thigh. The nerve acts as a guide to the vessel as it passes into this canal.

Hunter's canal, from one to two inches in length, is described as being formed by a dense fibrous aponeurosis, extending from the tendons of the adductors longus and magnus downward and inward to unite with the tendinous origin of the vastus internus muscle. It is triangular in shape, and bounded externally by the vastus internus, and internally by the adductor longus and adductor magnus muscles.

As the internal saphenous vein passes up the thigh to join the femoral, through the saphenous opening, it has an important relation to the points at which the incisions are made for exposing the artery in its lower and middle thirds, lying almost directly in the line of the incisions. The position of the vein should always be ascertained by making pressure over its course above, and it should be drawn to the inside while the incision is being made. In its course it receives numerous branches, which join it from the outer and inner surfaces of the thigh.

As ligation of the artery above the origin of the profunda femoris is not advised, it is important to determine the point at which this vessel is given off. Its normal point of origin is stated to be from one to two inches below Poupart's ligament, and from the outer and back part of the artery. Anomalies, with regard to its point of origin, are noted as occasionally occurring, the vessel being given off at or just below Poupart's ligament, and, in one instance, four inches below. It should also be remembered that occasionally the artery divides into two trunks below the origin of the profunda, and reunites before entering Hunter's canal.

A rare anomaly with regard to the position of the femoral artery is noted, in which the vessel occurred as a branch of the internal iliac artery, passed out of the pelvic cavity through the great sacro-sciatic foramen, and descended the thigh in its posterior aspect in connection with the great sciatic nerve. In the living subject, absence of pulsation at the crural arch would suggest the existence of such an anomaly.

Course—From a point midway between the anterior superior spinous process of the ilium and the symphysis pubis, down the front and inner side of the thigh, terminating at the opening in the adductor magnus muscle, this opening being at the junction of the middle with the lower third of the thigh. A line drawn from the point midway between the anterior superior spinous process of the ilium and the symphysis pubis to the inner side of the inner condyle of the femur, will indicate its course.

Surface marking—Inner edge of the sartorius muscle.

General relations: In front—Skin, superficial and deep fasciæ, and sartorius muscle.

Behind—Psoas, pectineus, adductor longus and tendon of adductor magnus muscles, femoral vein.

Inside—Femoral vein.

Outside—Anterior crural and internal saphenous nerves, vastus internus muscle.

Guide—Inner border of the sartorius muscle.

Structures to be avoided—Internal saphenous and femoral veins, internal saphenous nerve.

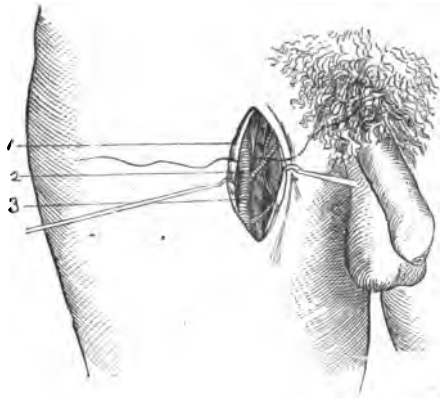
Common sheath—Including artery and vein.

OPERATION.—The common femoral, above the profunda femoris.

An incision two inches in length is made over the course

of the artery, beginning at a point midway between the anterior superior spinous process of the ilium and symphysis pubis, dividing the skin. The fasciæ are carefully divided on the director, and the sheath of the vessels exposed. Opening this to a slight extent, the vein is drawn inward, and the ligature needle passed from within outward (Fig. 108).

Fig. 108.



1. The deep fascia.
2. The femoral artery.
3. The femoral vein.

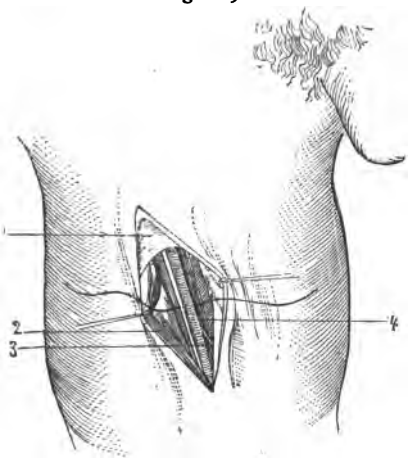
In the operation at this point, which is not advised, owing to the number of branches here given off from the artery, care should be taken to pass the ligature above the origin of the profunda femoris, and not immediately below it. This can be accomplished by bringing into view Poupart's ligament, and applying the ligature from three-quarters to one inch below. The fold of the groin should not be taken as a guide to the position of Poupart's ligament, as in those who are corpulent the fold is below the ligament, and not on a line with it.

OPERATION.—The superficial femoral artery at the apex of Scarpa's triangle, four inches below Poupart's ligament.

To apply the ligature to the artery at this point of its

course, the leg should be flexed upon the thigh, and the thigh abducted and rotated outward, the position of the internal saphenous vein ascertained by pressure applied above, and an incision three inches in length made along the inner border of the sartorius muscle, dividing the skin. The superficial and deep fasciæ are now divided on the director, and the border of the sartorius muscle sought. This muscle can be distinguished by the direction its fibres take obliquely downward and inward. Drawing the muscle outward, the sheath of the vessels is exposed, and should be opened to a slight extent. The ligature needle should be passed carefully from within outward, avoiding the vein (Fig. 109).

Fig. 109.



1. The deep fascia.
2. The sartorius muscle drawn aside.
3. The femoral artery.
4. The femoral vein.

In performing this operation, it should be remembered that the femoral vein lies at this point beneath the artery, and in close contact. Great care is to be exercised, therefore, in passing the ligature needle, in order that the vein should not be injured, and that it be not included in the ligature.

OPERATION.—The superficial femoral artery in Hunter's canal.

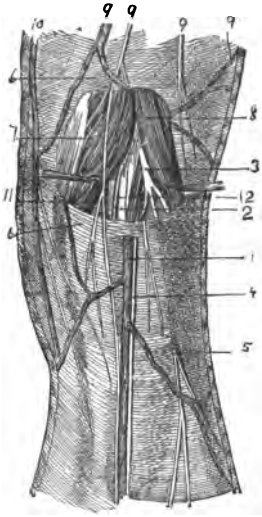
The limb being flexed and rotated outward, an incision from three to four inches in length, dividing the skin, is made in the course of the artery, over the point of junction of the middle and lower third of the thigh. The superficial and deep fasciæ are to be divided on the director, and the outer border of the sartorius muscle sought for. This muscle is drawn inward, exposing Hunter's canal, in which are placed the artery, vein, and the long saphenous nerve. The canal should be opened carefully on the director, and, nicking the sheath slightly, the ligature needle should be passed from without inward, avoiding the vein and long saphenous nerve.

Attention is directed to the position of the artery, vein, and long saphenous nerve as they lie in Hunter's canal. At this point the vein is to the outside; the nerve, while it is in the canal, and before it reaches the opening in the adductor magnus, quits the outside of the artery and passes across to the inner side of the thigh. A number of branches of the nerve are distributed to the vastus internus muscle, and may be mistaken for the internal saphenous. They may be distinguished by examining carefully their relations to the artery, being placed more externally than the saphenous nerve. The vastus internus muscle can be recognized by the direction of its fibres, which pass from above downward and outward.

The Popliteal Artery. SURGICAL ANATOMY.—The popliteal artery, the continuation of the femoral, begins at the opening in the adductor magnus muscle, and, passing obliquely downward and outward, terminates at the lower

border of the popliteal muscle, in the anterior and posterior tibial arteries (Fig. 110). In its course, it lies in close contact with the posterior ligament of the knee-joint (Fig. 174), occupying a lozenge-shaped space, called the popliteal space, which is placed between the lower third of the thigh and the upper fifth of the leg. The popliteal space is bounded above the knee-joint, externally, by the biceps muscle, and below the joint by the

Fig. 110.



1. External saphenous vein.
2. Popliteal nerve.
3. Peroneal nerve.
4. External saphenous nerve.
5. Branch of the peroneal nerve.
6, 6. Deep fascia.
7. Semimembranosus muscle.
8. Biceps muscle.
9, 9. Cutaneous vessels and nerves.
10. Internal saphenous vein.
11. Popliteal artery.
12. Popliteal vein.

Surgical Anatomy—Popliteal Artery.

plantaris and external head of the gastrocnemius muscles; above the joint, internally, by the semimembranosus, semitendinosus, gracilis, and sartorius muscles; below the joint, internally, by the inner head of the gastrocnemius muscle. The floor is formed, from above downward, by the lower part of the posterior surface of the shaft of the femur, the posterior ligament of the knee-joint, the superior extremity of the tibia, and the fascia covering the popliteus muscle. The fascia lata (deep fascia) covers in the space, forming

a firm protective membrane to the structures contained in it. The important bloodvessels and nerves are placed in the following order, from without inward: The internal popliteal nerve, the larger of the two terminal branches of the great sciatic is most superficial, being separated from the vessels which lie beneath by a thick layer of fat. In the upper part of the space it occupies a position to the outside of the artery, crossing it at the middle and passing to the inside as it leaves the space.

The popliteal vein, formed by the union of the venæ comites of the anterior and posterior tibial arteries, lies beneath the nerve. Occasionally the union does not take place below, and the artery is then embraced by the two veins which are in close contact with it. In the lower part of the space it is placed on the inner side of the artery, in the middle it is superficial to it, and crosses it to take a position on its outer side.

Beneath the nerve and the vein, the artery is placed in close contact with the posterior ligament of the joint. Numerous branches are given off from the artery and nerve to the joint and surrounding muscular structures, and the vein receives the external or short saphenous and branches from the joint and muscles.

The application of a ligature to the popliteal artery, owing to the relations it has to the surrounding structures, as well as the numerous branches arising from it at right angles, is, necessarily, an operation in which the greatest care should be exercised. Ligation may be performed in the upper or lower part of its course. The middle portion should not be interfered with, owing to its deep position, its proximity to the knee-joint, and its close relations with the vein and nerve.

Course—From the opening in the adductor magnus muscle, obliquely downward and outward to the lower border of the popliteus muscle, traversing the middle of the popliteal space.

Surface markings—Borders of the muscles which form the boundaries of the popliteal space.

General relations: In front—Above, the inner side of the femur; in the middle, the posterior ligament of the joint; and, below, the popliteal fascia.

Behind—The popliteal vein, layer of fat, internal popliteal nerve, fascia lata (deep fascia), superficial fascia, and skin.

Inside—Semimembranosus and inner head of the gastrocnemius muscles.

Outside—Biceps and outer head of the gastrocnemius muscles.

Guides—Above, the border of the semimembranosus muscle; below, the heads of the gastrocnemius muscle.

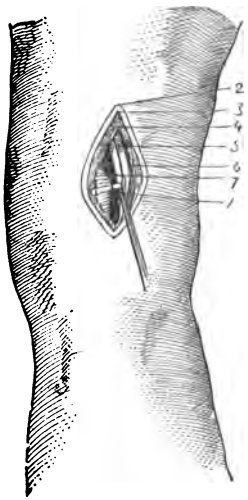
Structures to be avoided—External saphenous vein, popliteal vein, and internal popliteal nerve, with their branches.

OPERATION: *In upper third.*—The patient being placed in the prone position, with the limb extended, an incision three inches in length should be made along the posterior margin of the semimembranosus muscle, dividing the skin. The superficial and deep fasciæ are next divided carefully on the director, bringing into view the border of the semimembranosus muscle, which should be drawn inward, exposing the internal popliteal nerve lying to the outside. Separating carefully the layer of fat, which is usually found between the nerve and the vein and artery, the latter is sought for beneath the vein, and somewhat to its inner side.

Detaching cautiously the artery from the vein, the ligature needle is passed from without inward (Fig. 111).

In the lower third, between the heads of the gastrocnemius muscle.—An incision, three inches in length, should be made in the middle line, beginning opposite the bend of the knee-joint, dividing the skin. The superficial and deep fasciæ should be divided on the director, care being taken to avoid the external or short saphenous vein, which perforates the deep fascia in the lower part of the popliteal space to join the venæ comites. Superficial branches of the internal popliteal

Fig. 111.



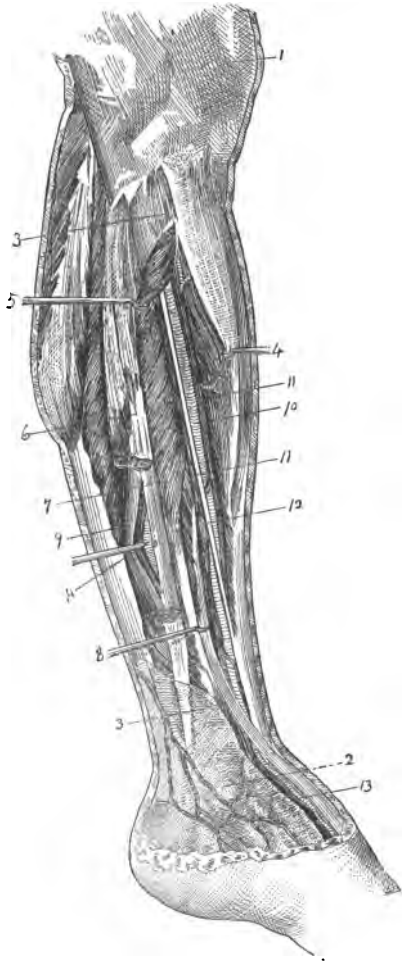
1. The popliteal artery.
2. The skin.
3. The superficial fascia.
4. The fascia lata (deep fascia).
5. The internal popliteal nerve.
6. The biceps muscle.
7. The popliteal vein.

nerve are also to be avoided in dividing the fasciæ. After the division of the deep fascia, the nerve, vein, and artery are found, placed in the order named from without inward, between the heads of the gastrocnemius muscle. Flexing the leg, so as to relax the heads of the gastrocnemius, the nerve and vein are cautiously separated from the artery, and the ligature needle is passed from without inward.

The Anterior Tibial Artery. SURGICAL ANATOMY.—At the lower border of the popliteus muscle the anterior

tibial artery is given off from the popliteal, and, passing between the two heads of the tibialis posticus muscle and then between the tibia and fibula in the interspace above the upper margin of the interosseus membrane, it reaches the anterior surface of the leg, and lies upon the interosseous membrane (Fig. 112). In the upper part of

Fig. 112.



1. Patella.
2. External malleolus.
3. Deep fascia.
4. Tibialis anticus muscle.
5. Extensor longus digitorum muscle.
6. Peroneus longus and brevis muscles cut across.
7. Border of fibula.
8. Extensor proprius pollicis muscle.
9. Flexor longus pollicis.
10. Anterior tibial artery.
11, 11. Venæ comites.
12. Anterior tibial nerve.
13. Dorsalis pedis artery.
14. The peroneal artery.

its course it is connected to the interosseous membrane by delicate bands of fibrous tissue, which pass over it; and below, it lies upon the anterior surface of the tibia and the anterior ligament of the ankle-joint, passing beneath the anterior annular ligament. As it descends it changes its relations to the muscles, by reason of the direction the tibialis anticus and the extensor proprius pollicis take to their points of insertions, lying above, between the tibialis anticus and extensor longus digitorum, in the middle portion of the leg between the tibialis anticus and extensor proprius pollicis, and in the lower part between the tendon of the extensor proprius pollicis and the inner tendon of the extensor longus digitorum. Its course may be indicated by a line drawn from the inner side of the head of the fibula to a point midway between the two malleoli.

The anterior tibial nerve lies to the outer side of the vessel in its entire extent. In the middle it is in very close relation, getting somewhat upon its anterior surface. Venæ comites are placed upon either side of the artery, and should be separated before passing the ligature.

Course—From the lower border of the popliteus muscle, forward through the interspace between the tibia and fibula above the upper border of the interosseous membrane, and downward on the anterior surface of the membrane to a point midway between the malleoli.

Surface markings—Crest of the tibia and tibialis anticus muscle.

General relations: In front—Skin, superficial and deep fasciæ, tibialis anticus, extensor longus digitorum, and extensor proprius pollicis muscles, anterior tibial nerve, and anterior annular ligament.

Behind—Interosseous membrane, tibia, and anterior ligament of the ankle-joint.

Inside—Tibialis anticus and extensor proprius pollicis muscles.

Outside—Anterior tibial nerve, extensor longus digitorum and extensor proprius pollicis muscles.

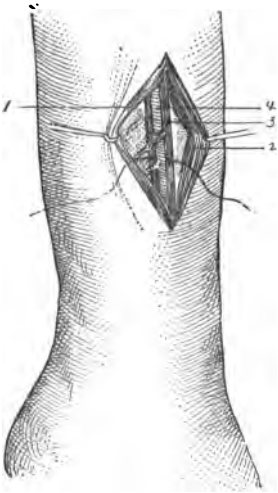
Guides—Tibialis anticus, tendons of the extensor longus digitorum and extensor proprius pollicis.

Structures to be avoided—Anterior tibial nerve and venæ comites.

OPERATION: *In the upper third.*—Turning the limb inward and extending it, an incision four inches in length is made over the course of the artery through the skin, midway between the crest of the tibia and the outer border of the fibula. The superficial and deep fasciæ are divided next on the director, and the septum between the tibialis anticus and extensor longus digitorum is sought for. This may be recognized as the first intermuscular space from within outward, and by a white line at the lower part of the wound. The different muscles should also be brought into action by moving the foot, which will assist in distinguishing the line of separation. Flexing the foot, so as to relax the muscles, they are separated with the handle of the knife or finger, and the artery brought into view as it lies on the interosseous membrane, embraced between the venæ comites, with the anterior tibial nerve to the outside. Separating the veins from the artery, the ligature needle is passed from without inward.

In the middle third.—At this point the artery is reached by an incision, three inches in length, over the course of the vessel, somewhat nearer to the crest of the tibia than above, dividing the skin. The fasciæ are divided, and the artery is found on the tibia, between the tibialis anticus and the extensor proprius pollicis muscles, with the

Fig. 113.



1. Extensor proprius pollicis and extensor longus digitorum muscles.
2. Tibialis anticus muscle.
3. Venæ comites.
4. Artery.

nerve lying over it. Separating the nerve from the artery, the ligature needle is passed from without inward (Fig. 113). In ligating the artery at this point, care should be taken to avoid making the incision too far from the crest of the tibia. It is to be remembered that the artery lies on the tibia.

In the lower third.—An incision three inches in length, dividing the skin, is made along the external border of the tibialis anticus muscle to the upper margin of the anterior annular ligament, which passes obliquely across the limb from above downward, from the external to the internal malleolus. The superficial and deep fasciæ are divided carefully on the director, and the artery sought for as it lies between the tendons of the tibialis anticus and extensor proprius pollicis, with the nerve to the outside. If not found in this position, it may be sought for beneath the tendon of the extensor proprius pollicis, or between this tendon and that of the extensor longus digitorum. The ligature needle is passed from without inward, the venæ comites having been separated from the artery. At this point of its course the artery is superficial, and deep dissections should be avoided in seeking it.

The Dorsalis Pedis Artery. SURGICAL ANATOMY.—The dorsalis pedis artery is the continuation of the anterior tibial, beginning at the point midway between the malleoli, and passing down the foot, near to the tibial border, to the first interosseous space. It is superficial in its entire extent, lying upon the bones of the tarsus, with the internal branch of the anterior tibial nerve to the outside. At its lower part the inner tendon of the extensor brevis digitorum crosses it (Fig. 114).

Fig. 114.

1. Anterior annular ligament of the tarsus.
2. Tendon of the extensor proprius pollicis muscle.
3. Tendons of the extensor longus digitorum muscle.
4. Extensor brevis digitorum muscle.
5. Dorsalis pedis artery.
6. Anterior tibial nerve.

Dorsalis Pedis Artery.

Course—From the bend of the ankle forward and downward to the first interosseous space. A line drawn from a point midway between the two malleoli to the space between the first and second metatarsal bones, indicates its course.

Surface marking—Extensor proprius pollicis muscle.

General relations: In front—Skin, superficial and deep fasciæ, inner tendon of extensor brevis digitorum muscle.

Behind—Astragalus, scaphoid, internal cuneiform bones and their ligaments.

Inside—Extensor proprius pollicis muscle.

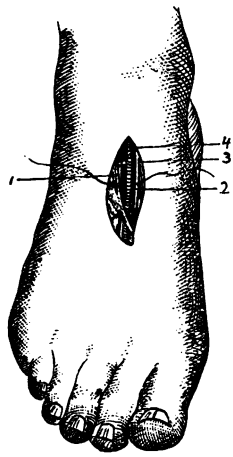
Outside—Extensor longus digitorum muscle and anterior tibial nerve.

Guides—Tendon of the extensor proprius pollicis muscle and inner tendon of the extensor brevis digitorum.

Structures to be avoided—Anterior tibial nerve and venæ comites.

OPERATION.—An incision, two inches in length, not extending below the upper point of the first interosseous space, is made along the outer border of the extensor proprius pollicis muscle, dividing the skin. The superficial and deep fasciæ are divided on the director, and the artery exposed, lying between the tendon of the extensor proprius pollicis muscle and the inner border of the extensor brevis muscle, with the nerve

Fig. 115.



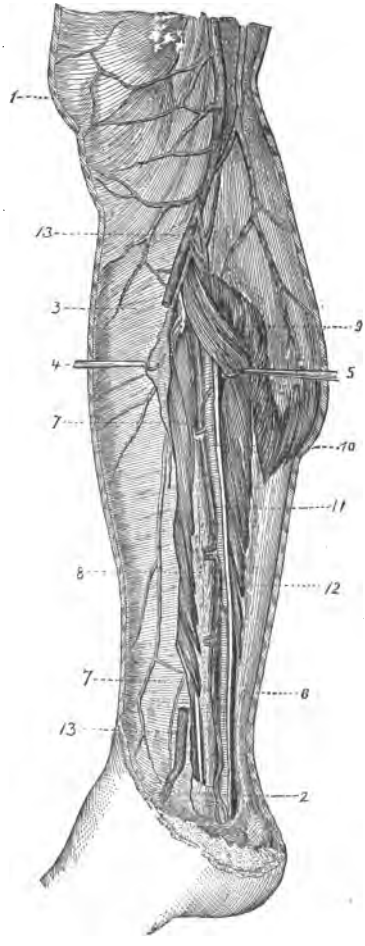
1. Inner tendon of the extensor brevis digitorum muscle.
2. Venæ comites.
3. Tendon of the extensor proprius pollicis muscle.
4. Dorsalis pedis artery.

to the outside. The ligature needle is passed from without inward, avoiding the venæ comites (Fig. 115).

The Posterior Tibial Artery. SURGICAL ANATOMY.—The posterior tibial artery is the larger of the terminal branches of the popliteal; arising at the lower border of the popliteus muscle, it passes obliquely, from without in-

ward, down on the posterior surface of the leg to the space midway between the internal malleolus and the tuberosity of the os calcis, where it terminates as the internal and external plantar arteries (Fig. 116). A line drawn from the middle of the popliteal space to a point behind the internal malleolus, will represent the direction it takes. In the upper part of its course it lies upon the tibialis posticus muscle, be-

Fig. 116.



1. Patella.
2. Internal malleolus.
3. Internal surface of the tibia.
4. Deep fascia.
5. Soleus muscle drawn aside.
6. Tendo Achillis.
7. Tibialis posticus.
8. Flexor longus digitorum muscle.
9. Gastrocnemius muscle.
10. Posterior tibial artery.
11. Venæ comites.
12. Posterior tibial nerve.
13, 13. Internal or long saphenous vein.

The Posterior Tibial Artery.

by its color and the transverse direction of its fibres. It separates the superficial and deep muscles, and *beneath* it the artery is placed with its veins and the posterior tibial nerve.

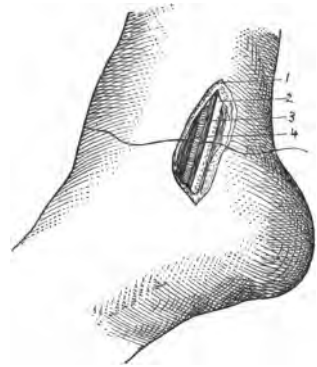
In dividing the attachment of the soleus muscle to the tibia, care should be taken to avoid severing at the same time the origin of the flexor longus digitorum. If this precaution is neglected, the substance of the muscle will be invaded and the artery missed. Its position should be remembered as being on the posterior surface of the tibialis posticus muscle, covered by the intermuscular septum.

In the middle third.—The limb being in the same position as for the ligation in the upper third, an incision three inches in length midway between the inner border of the tibia and inner edge of the tendo Achillis should be made, dividing the skin. Fixing the position of the internal saphenous vein, the superficial and deep fasciæ should be divided on the director, avoiding it. Seek the edge of the tendo Achillis, and divide the layers of fascia connected with it. The artery, surrounded more or less by fat, will be found along the inner edge of the flexor longus digitorum, accompanied by its veins, with the nerve to the outside. The ligature should be passed from without inward, avoiding the nerve.

In the lower third.—An incision two inches in length is made along the inner border of the tibia, and three-quarters of an inch posterior to it, dividing the skin. The sheath of the artery, with its venæ comites, will be found imbedded in fat, which is peculiar to this region. Separating the veins from the artery, the ligature should be passed from without inward, to avoid the posterior tibial

nerve, which lies to the outside. In this operation care should be taken to avoid opening the sheaths of the tendons which are placed on the posterior surface of the tibia (Fig. 118).

Fig. 118.



1. Skin and fasciæ.
2. Posterior tibial nerve.
3. Venæ comites.
4. Posterior tibial artery.

At the ankle.—A semilunar incision two and one-half inches in length should be made midway between the internal malleolus and the heel, dividing the skin. The strong and dense fascia (the internal annular ligament) covering the vessels and nerves, which is now exposed, and which is closely adherent to the sheaths of the tendons, should be divided cautiously on the director. The sheath of the vessels should be opened, the venæ comites separated from the artery, and the ligature passed from below upward, avoiding the posterior tibial nerve.

The Peroneal Artery. SURGICAL ANATOMY.—The peroneal artery arises from the posterior tibial and passes down the posterior surface of the leg along the outer or fibular side, terminating in branches on the back and outer side of the ankle. A line drawn from the posterior part of the head of the fibula to the external border of the tendo Achillis at the malleolus will indicate its course.

Course—From point of origin from the posterior tibial artery an inch below the lower border of the popliteus muscle, obliquely outward to the fibula, descending along its inner border to the ankle (Fig. 112, 14).

Surface marking—The fibula.

General relations: In front—Tibialis posticus and flexor longus pollicis muscles.

Behind—Soleus and flexor longus pollicis muscles, fasciæ, and skin.

Outside—Fibula.

Guide—Flexor longus pollicis muscle.

Structures to be avoided—The peroneal nerve.

OPERATION.—An incision three inches in length, parallel with, but behind, the external border of the fibula, should be made, dividing the skin. The attachment of the soleus muscle to the fibula must be divided, if necessary, and the muscle drawn inward. The origin of the flexor longus pollicis is to be detached, and the artery will be found to the inner side, lying beneath a strong aponeurosis on the anterior surface of this muscle, which must be divided. The ligature should be passed so as to avoid the peroneal nerve.

PART IV.

AMPUTATIONS.

AMPUTATIONS are operations which are performed for the purpose of removing a limb or a part of a limb from the body. The point of separation may be either in the continuity of the limb, through the bone, or at the articulation, between two or more bones.

INSTRUMENTS USED IN AMPUTATIONS.

The instruments required in performing these operations are knives, saws, bone-nippers, dissecting forceps, artery forceps, tenaculum, ligatures, sutures, suture-needles, scissors, retractors, and tourniquet.

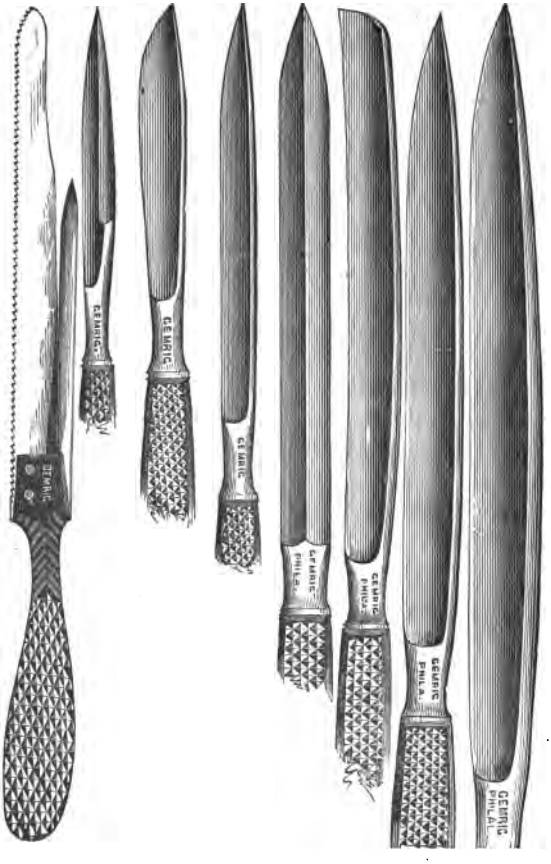
1. *Knives.*—These consist of amputating knives, large and small, the catlin, bistoury, and scalpel.

The *amputating knives* may vary in length from seven to twelve inches; in width, from three-eighths to three-quarters. They should have thick backs, the principal cutting edge extending the whole length of the blade, and the edge upon the back not longer than an inch and a half. They should be mounted in strong and roughened handles (Figs. 119, 120, 121).

The *catlin* or *double-edged knife* (Fig. 122) is used, and

forms part of the operating cases; it is employed to divide the inter-osseous membranes and intervening tissues in amputations of the forearm and leg. It can be dispensed with, the bistoury or scalpel accomplishing this

Figs. 126, 125, 124, 123, 122, 121, 120, 119.

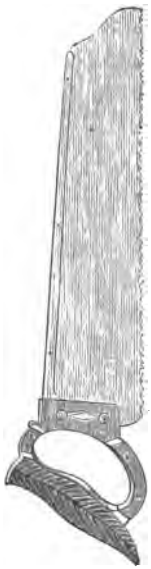


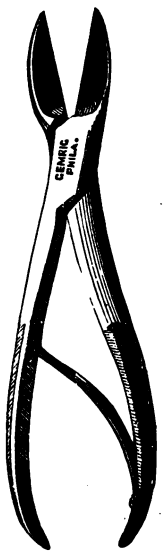
portion of the operation equally well. It should not be used to make flaps by transfixion, as the borders are liable to be cut in a jagged manner by the double-cutting edge of the instrument.

The *bistoury* should have a narrow, sharp-pointed blade three inches in length, with a strong back to it (Fig. 123).

The *scalpel* should have a strong blade three inches in length, with a broad body and a sharp point (Fig. 124).

Fig. 127. Fig. 128. Fig. 129.





2. *Saws.*—These may be of two kinds. The one for larger bones should be ten inches long by two and a half wide; strong, with heavy back, and teeth not too widely set (Fig. 127). For the bones of the hand, a small saw,

called the metacarpal saw, is employed (Fig. 128). A small saw, with a movable back, is used for the foot (Fig. 126).

3. *Bone-nippers* or *cutting pliers* are used for dividing the bone in amputation of phalanges or cutting off rough edges left by the saw. The blades should be short and sharp, and the handles long and strong (Fig. 129).

4. *Artery Forceps* are used to seize the divided vessels. The blades should be *toothed*, so as to hold firmly, and expanded a short distance above the point, in order that the ligature may slip over easily, and not include the point in the knot. They should fasten with a spring or catch (Figs. 130, 131).

Fig. 130.

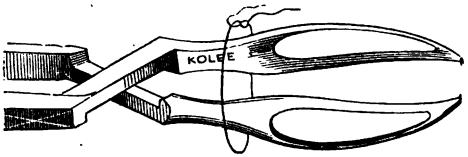
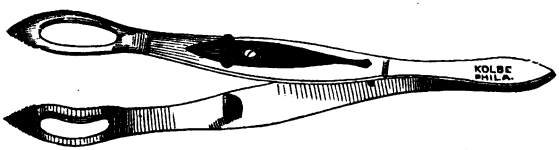


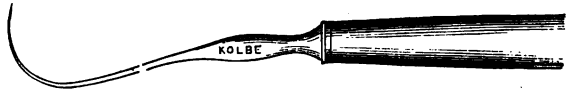
Fig. 131.



5. The *Tenaculum*—A sharp, slightly curved hook (Fig. 132). This is used to penetrate the coats of the vessels and hold it while the ligature is applied, or to pick up a mass of tissue when it is not possible to isolate the artery.

6. *Ligatures, Sutures, Suture Needles,* and *Scissors* have already been described (pp. 85–90).

Fig. 132.



7. *Retractors.*—These are formed from pieces of strong muslin, six to eight inches wide and of proper length to embrace the limb, one end being torn into two or three tails. They are applied around the bone to retract the soft structures, and prevent injury to them by the saw, and also to protect them from the bone dust (Figs. 133, 134).

Fig. 133.

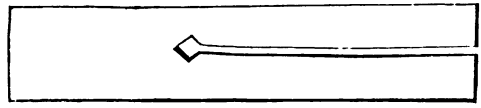
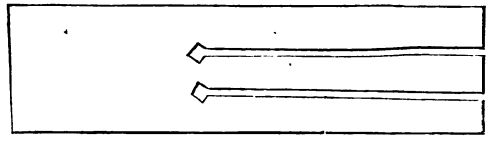


Fig. 134.



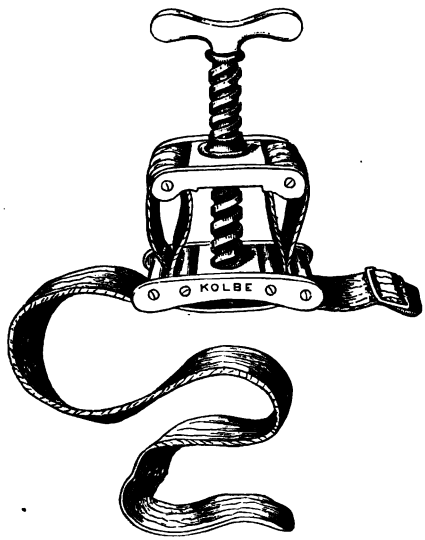
In securing the flaps in apposition by sutures, that first introduced should be in the centre, and should be carried in a direction so as to pass first through the most dependent flap. The remaining sutures should be applied on

either side of the first, alternately, so as to support the flaps equably and prevent dragging. Care should be taken to avoid the introduction of too many sutures—a sufficient number only to bring the edges in accurate apposition should be used. If the subcutaneous tissue protrudes between the edges of the flaps as they are drawn together, it should be turned in and the cut surfaces placed evenly in contact.

Compress, adhesive strips, and roller are required in the living subject to complete the dressing.

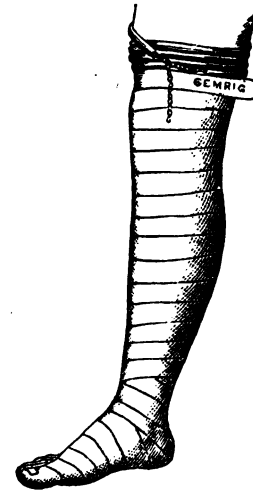
Methods of Controlling Hemorrhage.—In performing amputations in the living subject, it is necessary to

Fig. 135.



adopt means for controlling hemorrhage after section of the bloodvessels. For this purpose the tourniquet, an instrument devised by Morel in 1674 and subsequently modified by Petit, has been employed (Fig. 135). Within a few years, Prof. Esmarch, of Germany, has introduced an apparatus for bloodless operations, which consists of three yards of red elastic and four feet of rubber tubing, with hook and chain. The elastic bandage measures two and a half inches in width, and is applied to the limb by spiral turns, beginning at the distal point and terminating a short distance above the point where section is to be made. The rubber tubing, which is three-eighths of an inch in width, is then applied by two or more turns just above the border of the last turn of the bandage, and fastened securely by the hook and chain (Fig. 136). On removal of the bandage, the limb presents a blanched appearance, and on section the vessels and tissues are found free from blood. In the place of the red elastic an ordinary rubber band of the same length and width can be employed. To avoid a possible injury to the nerves of the part by undue pressure on the part of the rubber tubing, the author suggested, some years since, the substitution of a rubber band, measuring one and a half inch in width. It was

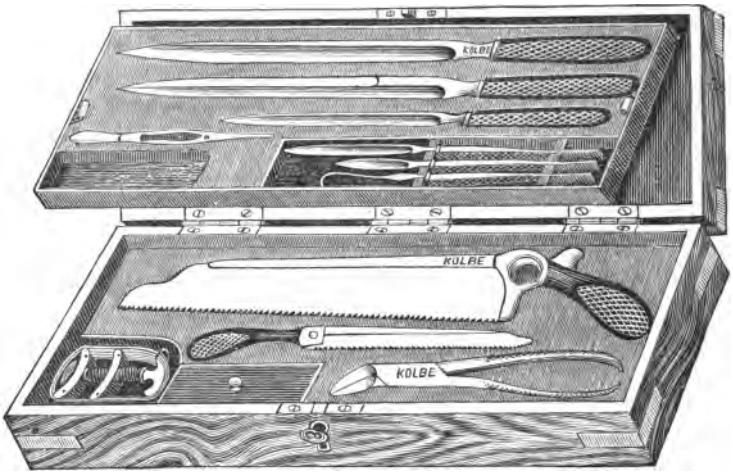
Fig. 136.



found to answer the purpose of making pressure equally as well as the tubing, and to avoid injury to the nerve structures.

The instruments which are required in performing am-

Fig. 137.



putations are arranged in a convenient manner in the amputating-case (Fig. 137).

METHODS OF AMPUTATION.

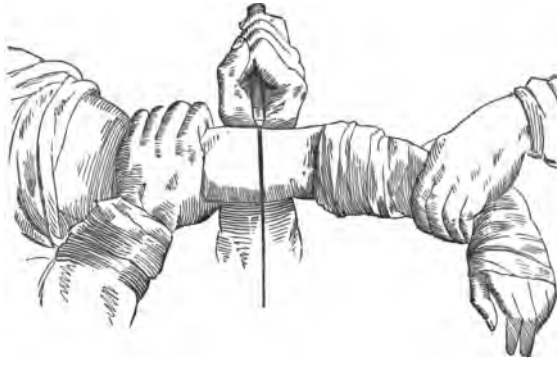
There are two principal methods of amputation: the circular and the flap. The oval may be regarded as a variety of the circular, and the rectangular of the flap method.

The Circular Method.—This operation may be described as consisting of three stages.

The first stage includes the division of the skin and superficial fascia; the second, that of the muscles and other structures to the bone; and the third, section of the bone.

In performing the operation, the operator stands so as to enable him to grasp the proximal part and retract the superficial tissues with the left hand; then, stooping so as to place his face on a level with the limb, he carries the amputating knife, held lightly in the right hand, around to the opposite side of the limb until the blade is perpendicular to the floor, pressing the heel firmly into the tissues (Fig. 138). He then makes a circular cut around

Fig. 138.



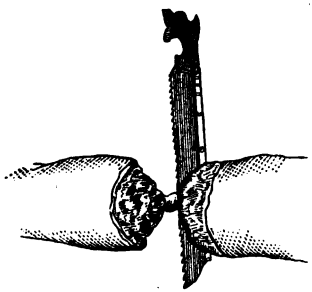
the limb, rising as he makes it, so as to complete the entire incision with one motion.

Separating the skin and fascia by careful dissection (Fig. 139) to the extent of two or two and a half inches, the cuff or fold thus formed is turned back, and the knife

is carried about the limb just below its border in the same manner as above described, dividing the muscles and other structures to the bone. A circular sweep is now made around the bone, dividing the periosteum, which, with the muscular structures, is dissected up to the extent

Fig. 139.

Fig. 140.



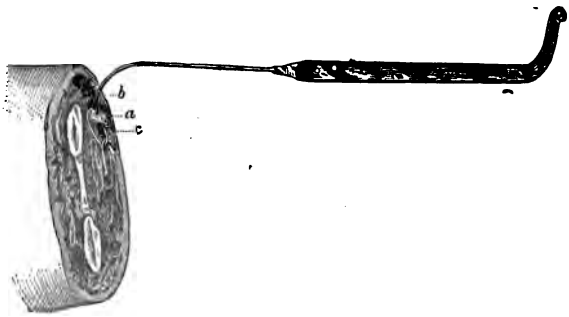
of an inch or more. The retractor is now applied, the tails being directed upward, and crossed in such manner that they, with the body of the retractor, completely cover the cut surfaces. The tissues being firmly pressed back, the saw, held *vertically*, is applied to the highest point exposed (Fig. 140), and drawn from heel to point, steadied carefully by the thumb-nail of the left hand, and the bone divided by short, light, and even strokes. If two bones are to be sawn, the saw should be used so that the smaller and most movable shall be divided first.

The vessels are now to be ligated, spiculæ of bone (if any exist) removed by the bone nippers, the projecting ends of nerves and tendons retrenched, and the edges of the fold of skin brought into apposition transversely, and fastened together by means of sutures.

Fig. 141.

In ligating arteries after amputation, the divided end is to be seized with the artery forceps (Fig. 141) or transfixed by the tenaculum, and *drawn out* (Fig. 142) from

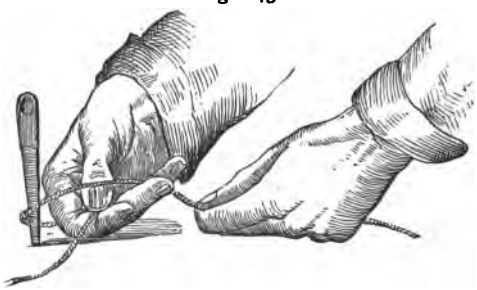
Fig. 142.



the tissues so as to isolate it—any structures which adhere to the artery can be pushed back by the handle of the knife, or carefully removed by dissection. Great care should be taken to avoid the inclusion of the nerve in the ligature, else the most serious consequences may ensue. It is important that the end should be cut across straight, and not obliquely, and that the ligature should be applied a sufficient distance from the divided end to insure complete occlusion of the vessel. One end of the ligature should be cut off close, and the other brought out between the flaps at the nearest point to the surface. The most important vessel may be indicated by a knot tied in the ligature, or the two ends may be allowed to remain, and be then knotted.

It is important that the ligature should be applied securely to the artery, and to accomplish this the reef-knot should always be used. To tie this knot successfully

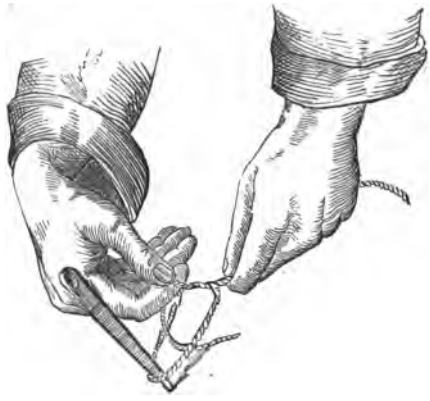
Fig. 143.



the following method is given by Mr. Heath: The ligature is to be held in the palm of the right hand between the thumb and index finger, the end is then to be thrown

round the forceps closely and caught with the left hand; the right hand is now brought under the end in the left, when that end is to be crossed over the right thumb and inserted between the third and fourth fingers of the right hand (Fig. 143), the left hand at the same moment siezes the outer end, and thus an interchange is effected, and the ends of the threads are drawn out (Fig. 144). The

Fig. 144.



index fingers or thumbs can be used to draw this knot tight (Fig. 145). The knot is completed by another tie, the same manœuvre being effected, taking care to begin with the *opposite* hand to that which began before.

As the ligatures are liable to become adherent to the dressings, it is a good plan to fasten them to the surface by short pieces of adhesive plaster, so as to prevent them from being pulled upon when the dressings are removed.

The projecting ends of the nerves should be removed, in order to prevent them from being held between the

flaps, and thus, after union has occurred, liable to be submitted to pressure. The tendons should be cut off close, as their presence interferes with the healing process.

Several points are to be noted by the student in the circular operation. When the circular cut around the limb is made, care should be taken that the point of the knife

Fig. 145.

does not strike the face as it turns. It happens sometimes that the incisions are not made successfully because the knife is drawn around the part, *the heel alone being kept in contact with the surface.* The knife should be drawn gradually from heel to point as it passes around the limb, finishing the cut with the point. The amount of pressure to be employed varies somewhat with the condition of the part and of the knife, whether sharp or dull. Practice alone will enable the student to acquire proper knowledge upon this point.

Before making the second incision, it is directed that the cuff of skin and fascia, which has been formed, should be turned up. In some cases, owing to the conical shape

of the limb, this may be difficult to accomplish. When it is found difficult to turn this back, it should be slit open at one side.

In making the second incision, the assistant should hold back the cuff, so as to avoid its section as the knife is carried around the limb.

The periosteum is directed to be dissected up to some distance; this is desirable, in order to secure good repair in the divided end of the bone and prevent exfoliation.

In sawing the bone the saw should be held vertically, so as to divide it from side to side, and thus avoid a liability to fracture or splintering. Proper care should always be taken in supporting the portion to be removed during this part of the operation.

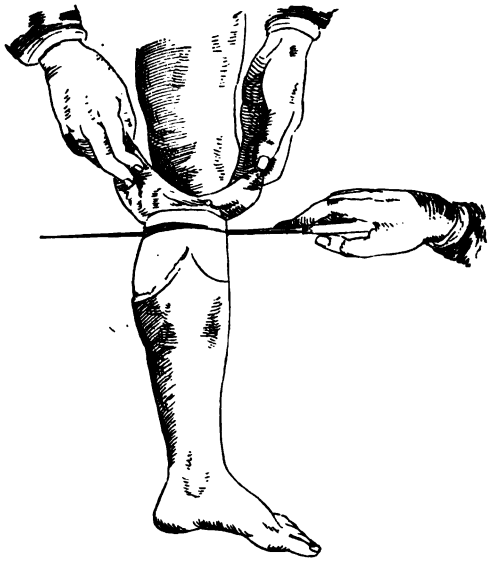
The manner in which the limb is held and supported is of great importance, as splintering and fracture occur frequently from want of proper knowledge upon this point. The limb should be covered with a towel or bandage, so that a firm grasp can be taken; and, while it is firmly supported, without being raised up or down, it should be drawn away with moderate force from the body in the line of its long axis. This action will cause a separation of the ends, and prevent binding of the saw, while steady support combined with it, will remove the weight of the limb.

The circular method of amputation can be employed at any part of the limb; it is preferably used where there are two bones or an absence of muscular structures, as in the lower portions of the forearm and leg.

The Modified Circular Method.—This name is given to an operation which consists in forming two short flaps

of skin and superficial fascia by cutting from without inward, and dividing the muscles by a circular incision (Fig. 146). It may be employed in cases where there is a redundancy of muscular tissues.

Fig. 146.



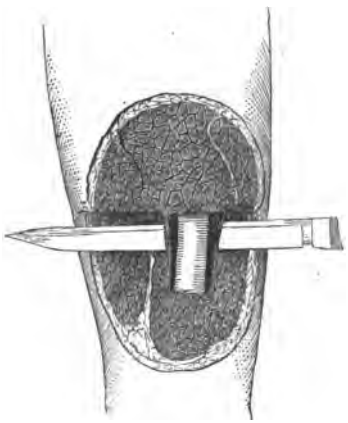
The Flap Method.—Amputation by the flap method consists in the division of the tissues so as to form one or more flaps, with which the end of the bone is covered. These flaps may be made by cutting from *without inward* to the bone, or from *within outward*, the knife transfixing the tissues, and cutting from the bone to the surface. In some instances, one flap is made in the first way, and the

other in the second. The flaps may vary in number from one to two or more, according to the circumstances of each case. The length also varies according to the size of the limb. A safe rule to adopt is to make them equal in length to three-quarters the diameter of the limb at the point of section of the bone. They may be made antero-posteriorly, laterally, or obliquely, and may include all of the structures to the bone, or may be made of skin and fascia alone, the muscles and other structures being divided circularly. They may be cut of equal length, or one may be longer than the other, according to the amount of muscular tissue in the part involved. They are, as a rule, convex in shape, terminating in a point more or less oblique. Care should be taken to avoid making them too oblique; and it should be remembered that it is always better to have an abundance of tissue rather than too small an amount. In the one case the redundant tissue can be retrenched; in the other it may be found difficult to supply the deficiency. If, in any case, the flaps are found to be too short, and there is danger of protrusion of the bone, the bone should then be sawn through at a higher point.

In performing the operation by transfixion the operator stands so as to grasp the proximal part of the limb firmly with the left hand. Raising the tissues so as to see that the flaps to be made will be, as nearly as possible, of equal size, the point of the amputating knife is entered on the side, midway between the upper and lower borders of the limb, and pushed inward until it strikes the middle of the bone. The handle of the knife is then depressed until the point is carried over the bone, and then elevated, returning the blade to the horizontal position, in order to

bring the point out exactly opposite to the point of entrance. The knife, still in the horizontal position, and in close contact with the bone, is carried downward with a sawing motion to a sufficient distance, and then. turning its edge to about an angle of 45°, it is carried upward and outward until the tissues are divided. In cutting outward, the handle of the knife should be gradually turned in the hand, so that when the edge leaves the tissues it will look directly upward. In this way, a pointed flap will be avoided. Turning back the flap, the knife is reentered at the same point as before, carried under the bone by movements similar to those used in making the first flap, the point brought out as before (Fig. 147), and the flap cut in the same way as the first. The flaps are now held back by the retractor, and the remaining tissues and periosteum divided by a circular cut of the knife. The periosteum is dissected back to a sufficient extent, and the bone sawn. The arteries are ligated, nerves and tendons retrenched, and sutures introduced, as described in the circular method.

Fig. 147.



In transfixing the tissues in this operation in the arm and thigh, it is important that the principal artery should

not be pierced by the point of the knife in making the first flap, as a punctured wound or a longitudinal slit will be made in the vessel which may cause serious trouble, the operator being compelled to dissect back to a sound portion of the artery in order to apply the ligature. If the position of the main artery is well ascertained before the incisions are commenced, the point of the knife can be passed so as to avoid it. An effort should always be made to leave it in the flap which is made last, thus deferring its division to the later stages of the operation.

In the arm and thigh, where the superficial fascia is usually abundant and the skin is very elastic and moves readily over the subjacent muscular tissues, care must be taken, in cutting from within outward, to retract the skin firmly, so that when the section is completed the muscles and skin will be divided on the same line. If this important injunction is unheeded, the operator will find a projecting mass of muscular tissues without sufficient skin to cover them. This mass should be retrenched, otherwise, if an attempt is made to pull the skin forcibly over it and then apply sutures, these will cut through, owing to the undue tension. It may be advisable, in some instances, when cutting from within outward, to turn the knife so as to divide the muscles at a higher point than the skin, thus reducing the muscular mass in the flap and giving a longer skin flap.

In forming antero-posterior flaps by transfixion, the anterior flap should be made first. In the lateral flap operation, the outer flap should be cut first. As a rule, the principal artery should be contained in the flap formed last.

An effort should be made, in cutting the flaps in the

living subject, to form them with regard to shape and size, so as to obtain a stump to which an artificial appliance can be adapted with comfort to the individual, the line of the cicatrix being so placed as to be free from pressure.

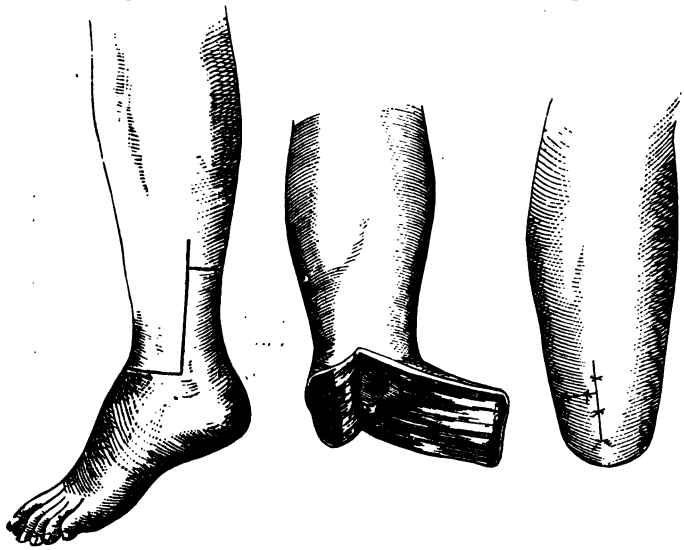
In the flap method, the flaps may also be made by cutting from without inward. When this plan of forming them is adopted, the amputating knife or, if preferred, a large scalpel should be entered on one side, at the point fixed upon for section of the bone, and carried over the front of the limb, making a curvilinear incision downward to the extent necessary to give proper length to the flap, bringing it out at a point just opposite to that of entrance. With this incision, the skin and superficial fascia, or the entire structures to the bone, are divided. The posterior flap may be formed in the same way, or by transfixion.

The Oval Method (Scoutetten's method). — This method, as stated above, may be regarded as a modification of the circular. It may be employed when amputation is performed in the continuity of a limb, but it is more frequently adopted in disarticulations or amputations through the joints. The incision is made by introducing the knife a few lines above the point of section of the bone or above the joint, carrying it downward in a vertical line for a short distance, and then sweeping it about the limb in an oblique direction, dividing all the structures to the bone, and returning to the point of entrance. It may also be made by two incisions in the shape of the letter V reversed, these being made first and then united by a transverse cut.

The Rectangular Flap Method (Teale's method).— This is a modification of the double flap, and consists in

forming two rectangular flaps, a long and a short one. The length and breadth of the long flap should be equal to *one-half* (preferably one-third) *the circumference* of the limb at the point of section of the bone, and the short flap, *which should contain the vessels*, should measure *one-eighth the circumference*, or *one-fourth the length* of the long flap. The lines of incision should be traced out upon the part (Fig. 148), and in cutting the flaps the knife

Fig. 148. Fig. 149. Fig. 150.



should be carried to the bone, including all of the structures. The flaps should be dissected up, and the bone divided as in the other methods, care being taken to remove all rough points and spiculæ (Fig. 149). The long flap is

then drawn over the end of the bone, and attached by sutures to the short one at the end and sides. The apposed edges of the long flap should also be secured by sutures (Fig. 150).

The principal points to be observed in performing amputations may be embraced in a few general statements:

I. The patient or subject should be placed in the recumbent position; the operator should take a position which will permit him to control his movements without restraint. The table should be firm and high, so as to prevent motion and unnecessary fatigue to the operator in bending over it.

II. The assistants should perform the duties assigned them with promptness; no delay on their part should attend the delivery of the instruments as they are required, the supply of sponges in proper condition, the supply and the proper application of the ligatures. Perfect quietude should be maintained, and no conversation should be indulged in except that which relates to the performance of the operation in hand. The office of the assistant who administers the anæsthetic agent is a most responsible one; his entire attention should be given to the duty assigned him. He should carefully watch the state of anæsthesia in which the patient is placed, as manifested by the circulation, respiration, and other symptoms. He should endeavor to maintain a uniform effect upon the patient of the agent used; under no circumstances should he leave the patient or take part in any of the other duties of the operation.

III. The proximal part should be grasped firmly, and the integument drawn upward so that sufficient length will be given to this portion of the flap. Care should always

be taken to cut the flaps of sufficient length. Redundant tissues should be retrenched. Flaps cut too short require section of the bone at a higher point.

IV. As a general rule, as little of the bone as possible should be sacrificed. In amputations for the removal of diseased structures, it is important to cut through the bone at a point sufficiently beyond the disease to insure healthy flaps. In injuries, on the contrary, all of the soft structures remaining should be utilized in forming the flaps, and as much of the bone saved as possible.

V. The periosteum should be dissected up to the extent of an inch or more, so as to assist in the reparative process which occurs about the end of the bone.

VI. The bloodvessels requiring ligation should be completely isolated before the ligatures are applied. Great care should be taken to avoid the inclusion of the nerve in the ligature. The projecting ends of the nerves and tendons should always be cut off.

VII. In approximating the edges of the flaps, the sutures should be introduced to such depth as is necessary to afford proper support. In removing the sutures, they should be cut with the scissors at the side, just beyond the edge of the wound, and withdrawn, the borders of the wound being supported by the thumb and index finger of the free hand. If wire sutures are used, they should be divided in the same manner, or untwisted, the cut, or free, ends being bent back so as to straighten them, and the suture removed by gentle, even traction; usually more force is required to remove the wire suture, and, therefore, care should be taken to support carefully the edges of the wound.

SPECIAL AMPUTATIONS.

THE LOWER EXTREMITY.

Amputation of the Foot. SURGICAL ANATOMY.—The foot is the terminal part of the lower extremity, and consists of three portions, the tarsus, metatarsus, and phalanges (Fig. 151).

Bones.—The *Tarsus* is composed of seven irregular bones, the os calcis, astragalus, cuboid on the outside, scaphoid on the inside, internal, middle, and external cuneiform bones, placed between the cuboid and the inner border of the foot.

Fig. 151.

1–5. Metatarsal bones.
6. Tibia.
7. Fibula.
8. Astragalus.
9. Os calcis.
10. Scaphoid.
11. Cuboid.
12. Internal cuneiform.
13. Middle cuneiform.
14. External cuneiform.
15–15. Phalanges.

The *Metatarsus* consists of five bones, numbered from within outward, and classified as long bones.

The *Phalanges* are fourteen in number, two for the great toe and three for the remaining toes, and are enumerated from the metatarsus. These are also classified as long bones.

Ligaments. — The bones of the tarsus are attached to each other by strong dorsal, plantar, and interosseous ligaments, with intervening synovial membranes. The articulations between the various bones of the tarsus are of the diarthrodial form, embracing the arthrodia and the enarthrosis. The metatarsal bones are united to the last row of tarsal bones and to each other by dorsal, plantar, and interosseous ligaments. They are

connected with the first phalanges by an anterior plantar and two lateral ligaments.

The phalanges are bound together by plantar and lateral ligaments. Synovial membranes line the joints.

Muscles.—The upper or dorsal surface of the foot is covered by the tendons of the extensor muscles, which take origin on the anterior surface of the leg, and by the fleshy bellies of the extensor brevis digitorum.

The plantar surface or sole of the foot is well protected by the dense plantar fascia and the thick, fleshy masses formed by the flexor brevis digitorum and muscles of the great and little toes. The spaces between the metatarsal bones are occupied by dorsal and plantar interossei muscles.

Articulations.—As amputation is performed at the various articulations of the foot, it is important to study the nature and position of these very carefully. The articulation of the phalanges with each other and with the metatarsus is quite regular, and does not differ materially from that observed in the hand. Between the metatarsus and the second row of bones of the tarsus, the line of articulation is irregular, owing to the projection backward of the head of the second metatarsal bone, and its interlocking with the three cuneiform bones (Fig. 151). The mortise formed by the three cuneiform bones has the following measurements: the internal wall is one-third of an inch deep, and has a direction obliquely backward and outward; the external wall is one-sixth of an inch deep, and its direction is obliquely backward and inward; the posterior wall measures about one-half of an inch in width, and is transverse. This position of the head of the second metatarsal bone should be particularly borne in mind in the attempts to effect disarticulation. The position of the

articulation on the outside is indicated by a point just behind the tuberosity of the fifth metatarsal bone. On the inside it lies one inch in front of the tuberosity of the scaphoid.

The next line of articulation is a partial one existing between the heads of the three cuneiform bones and the base of the scaphoid, limited on the outside by the body of the cuboid. In disarticulation through the tarsus, this articulation is sometimes opened by mistake. The error can be detected at once by observing the three articulating facets on the base of the scaphoid.

The line of articulation between the astragalus and scaphoid and the os calcis and cuboid is, in its nature, compound, being convex anteriorly between the astragalus and scaphoid, and concavo-convex anteriorly between the os calcis and cuboid. On the outside, a point midway between the external malleolus and the tuberosity of the fifth metatarsal bone, indicates the position of the articulation, while a point just back of the tuberosity of the scaphoid fixes the position on the inside.

Bloodvessels.—The arteries which supply the foot are the dorsalis pedis, on the dorsal surface, and the plantar arteries on the plantar surface, with their venæ comites. On a level nearly with the line of articulation, between the tarsus and metatarsus, the arteries form arches across the surfaces of the foot, from which are given off branches which terminate in two digital branches on each surface of the toes.

Nerves.—The nervous supply to the foot is derived from the anterior tibial and musculo-cutaneous on the dorsal surface, and the plantar nerves on the sole of the foot. Digital branches are given off, which follow the course of the arteries.

Amputation of the Toes. *Methods.*—At the phalangeal articulations, or in the continuity of the phalanges, by the circular or flap methods. At the metatarso-phalangeal articulations, by the oval method.

OPERATION. *Through the articulation: Single-flap method.*—The toe being firmly grasped and flexed, a transverse incision is made with a small narrow-bladed knife, cutting directly into the joint on the dorsal surface, over the most distinct fold which has been taken as a guide to the joint. The lateral ligaments are now to be divided, and the blade of the knife is introduced behind the head of the phalanx to be removed. The toe being extended, the knife is carried downward and forward toward the end in close contact with the bone, making a flap of the requisite length to cover the end of the bone. If necessary, the digital arteries are ligated, the nerves and tendons retrenched, and the flap brought up over the end of the bone, and held in apposition by means of sutures.

Circular method.—Amputation may be performed by this method through the articulation by making an incision three or four lines below, dividing the skin. Dissecting this up to the joint, the ligaments are divided and disarticulation effected. The cuff of skin is approximated in the transverse direction.

Amputation in the Continuity of the Bones.—Either the circular or flap method may be employed in performing this operation. The incision being made and the flaps formed, as above described, the bone is divided with the small saw or cutting pliers. The flaps are held in apposition by sutures, applied as in the other forms.

Amputation through the Metatarso-phalangeal Articulation. *By the Oval method.*

OPERATION.—The toe being flexed, the incision is made on the dorsal surface one-quarter of an inch above the joint, and carried obliquely down to the commissure, then across the plantar surface to the opposite side, the toe being extended, and thence obliquely upward to the point of departure. The extensor tendon, the lateral ligaments, and flexor tendons are to be divided in the order named, effecting disarticulation. The vessels are ligated, the tendons and nerves retrenched, and the edges of the wound approximated in a linear direction. In this operation the head of the metatarsal bone may be removed, if deemed necessary.

Amputation of the Great Toe. *By the Oval method.*

OPERATIONS.—1. This operation is performed by an incision beginning on the dorsum of the foot one-quarter of an inch above the joint, and then carrying it obliquely downward and forward on the outer side of the toe to the

Fig. 152.

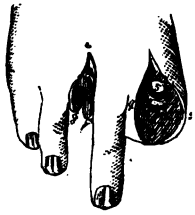
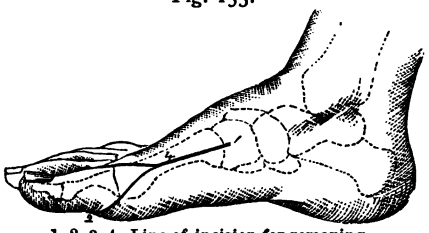


Fig. 153.



1, 2, 3, 4. Line of incision for removing first metatarsal bone with great toe.

commissure of the toes, then under the toe to the outer side, and terminating at the point of departure (Fig. 152).

The flaps are dissected up to the joint, the extensor tendons, lateral ligaments, and the flexor tendons are divided, completing disarticulation. The arteries are ligated, the tendons retrenched, and the flaps approximated in a linear direction (Fig. 153).

2. The great toe may also be removed by making a straight incision on the inner surface of the foot, beginning one-half of an inch above the joint, and carrying it downward to the middle of the first phalanx. From the termination of this incision, a slightly curved incision is made on the dorsal surface to the commissure of the toes, and then one is made in a similar way on the plantar surface, joining the one first made. These flaps are dissected up to the joint, disarticulation effected, and sutures applied so as to bring the edges together in a transverse direction. In performing these operations, care should always be taken to secure ample flaps to cover the large surface which the head of the first metatarsal bone presents.

Amputation of the Little Toe. *By the Oval method.*

OPERATION.—This toe can be removed by incisions made in the same manner as those employed to effect disarticulation of the great toe.

Fig. 154.

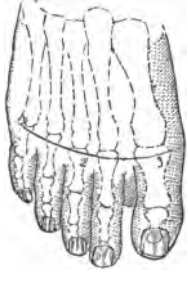
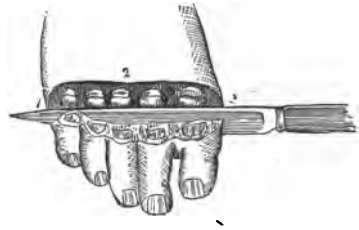


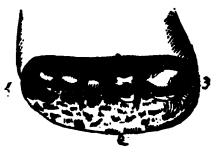
Fig. 155.



Amputation of all of the Toes. *By the Flap method.*

OPERATION.—Fix the positions of the articulations (Fig. 151), and make a semilunar incision a short distance in front of them, carrying it from one side to the other (Fig. 154). A short flap is then dissected up, the joints exposed, and opened by dividing the extensor tendons and lateral ligaments. The knife is passed behind the phalanges (Fig. 155), and the flap, of requisite length, is made from the plantar surface (Fig. 156). The vessels are ligated, the tendons retrenched, and the plantar flap is drawn up over the ends of the metatarsal bones, and secured by suture to the dorsal flap.

Fig. 156.



Amputation in the Continuity of the Metatarsal Bones. *By the Flap method.*

OPERATION.—Amputation through the metatarsal bone is performed by making a semilunar incision on the dorsum of the foot, a short distance below the point of section of the bones, dividing all of the tissues to the bones. Dissect up the integuments to a slight extent, and form a plantar flap by transfixion, introducing the knife, carrying it, in close contact with the bones, to the commissure of the toes. The flaps are retracted by a six-tailed retractor, four of the tails being passed through the four interosseous spaces, and the bones divided by the metacarpal saw. The vessels are ligated, the tendons on the dorsal and plantar surfaces retrenched, and the plantar flap placed over the divided ends of the bones and secured to the dorsal flap by sutures.

Amputation at the Tarso-metatarsal Articulation. *By the Flap method* (Lisfranc's operation).

Bones.—The bones entering into the formation of the articulation are: internal, middle, and external cuneiform, articulating in order with the first, second, and third metatarsal bones, cuboid articulating with fourth and fifth metatarsal bones.

Ligaments.—The ligaments are the dorsal, plantar, and interosseous.

Line of the articulation.—A line drawn from a point behind the tuberosity of the fifth metatarsal bone across the dorsum of the foot, to a point one inch in front of the tuberosity of the scaphoid bone.

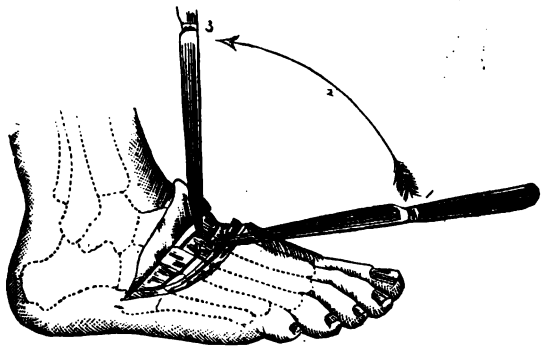
OPERATION.—Grasping the foot firmly, a curvilinear incision, dividing the skin and fasciæ, should be made,

Fig. 157.

Fig. 158.

with a strong scalpel, over the dorsum of the foot between the points above given, passing a short distance below the line of the articulation (Fig. 157). The skin and fasciæ should be dissected up to a slight extent, and another incision, across the foot, on a level with the edge of the retracted skin, should be made, dividing the remaining structures down to the bones. The dorsal ligaments should now be divided from the fifth to the second metatarsal bone, then the dorsal ligament connecting the first metatarsal bone to the internal cuneiform, and lastly, the dorsal ligament between the second metatarsal bone and the middle cuneiform, bearing in mind that the line of the articulation between the second cuneiform bone and the second metatarsal bone is one-third of an inch above the others (Fig. 158). The knife, being held at an angle of 45° to the axis of the foot, with the edge turned upward,

Fig. 159.



should now be introduced between the first and second metatarsal bones, and carried up to a right angle, dividing

with its point by this movement the ligament which binds the head of the second metatarsal bone to the outer surface of the first cuneiform bone (Fig. 159.) Complete division being effected by giving the knife a rocking motion, it is withdrawn and applied in the same manner between the second and third metatarsal bones, and the head of the second metatarsal bone separated from the inner surface of the third cuneiform bone. Depressing the foot firmly, the joint is opened and the remaining attachments can be divided. The plantar ligaments and the tendons of the peronei muscles should now be divided. An amputating knife is then introduced beneath the heads of the metatarsal bones (Fig. 160), and a flap made from

Fig. 160.

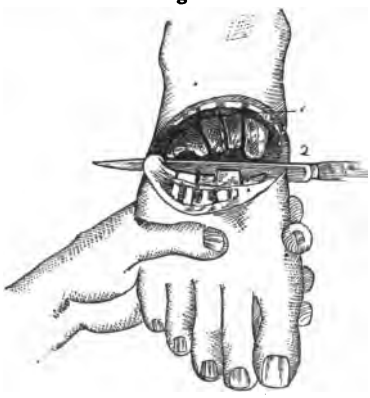


Fig. 161.

the sole of the foot by carrying the knife forward in close contact with the surfaces of the bones, care being taken to avoid the sesamoid bones of the great toe. The flap should

be terminated at the roots of the toes by a broadly convex border (Fig. 161).

The dorsalis pedis in the upper, and the two plantar arteries in the lower flap are divided, and may require ligation. The tendons being retrenched, the plantar flap is brought up over the exposed surfaces of the bones of the tarsus, and united to the upper flap by sutures.

Amputation at the Tarso-metatarsal Articulation. (Hey's operation.)

This operation is a modification of that just described, and differs from it in the method of forming the flaps and in the section of the internal cuneiform bone.

OPERATION.—A transverse incision, dividing the structures to the bone, is made across the foot, extending from the tuberosity of the fifth metatarsal bone to a point midway between the head of the first metatarsal bone and the tuberosity of the scaphoid. From the extremities of this incision, lateral incisions are made to the toes, and are connected by an incision across the sole of the foot, disarticulating the toes. A flap from the sole of the foot is dissected back to the articulation, and disarticulation of the second, third, fourth, and fifth metatarsal bones effected by dividing the dorsal, plantar, and interosseous ligaments. The separation is now completed by dividing with the saw the projecting portion of the internal cuneiform bone. The remaining steps of the operation are performed in the same manner as described in Lisfranc's operation.

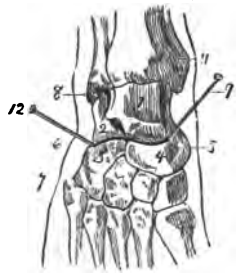
Section of the second metatarsal, instead of the internal cuneiform bone, has been suggested in amputation at the tarso-metatarsal articulation. Also, disarticulation of the first metatarsal bone, and section of the remainder on a level with the internal cuneiform.

Amputation at the Medio-tarsal Articulation. *By the flap method* (Chopart's operation).

Bones.—The bones entering into the formation of the articulation, on the inside, are the astragalus behind with the scaphoid in front; outside, os calcis behind, with the cuboid in front (Fig. 162).

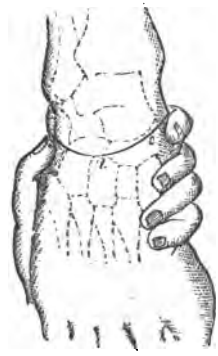
Ligaments.—Dorsal: superior astragalo-scaphoid, superior calcaneo-scaphoid, superior calcaneo-cuboid, and internal calcaneo-cuboid or interosseous. Plantar: inferior calcaneo-scaphoid, long and short calcaneo-cuboid.

Fig. 162.



1. Astragalus.
2. Os calcis.
3. Cuboid.
4. Scaphoid.

Fig. 163.



Line of the articulation.—A line drawn across the dorsum of the foot from a point one-half to three-quarters of an inch behind the head of the fifth metatarsal bone to a point one inch in front of the internal malleolus, or immediately behind the tubercle on the scaphoid bone. This line will be three-quarters of an inch in front of the ankle-joint.

OPERATION.—Grasping the foot with the left hand so

that the thumb and index finger shall rest at the points given on the inner and outer side of the foot, indicating the position of the articulation, the knife, a strong scalpel, should be carried across the dorsum of the foot, making a short, slightly convex flap (Fig. 163). Dissecting up the integuments to a slight extent, a second incision should be made on a level with the retracted flap, dividing the remaining structures down to the bones. Fixing the line of the articulation, the dorsal and interosseous ligaments are divided, exposing the joint fully. Dividing the plantar ligaments, an amputating knife is placed beneath the bones (Fig. 164), and a flap of sufficient length made from the sole of the foot (Fig. 165). The arteries which are di-

Fig. 164.

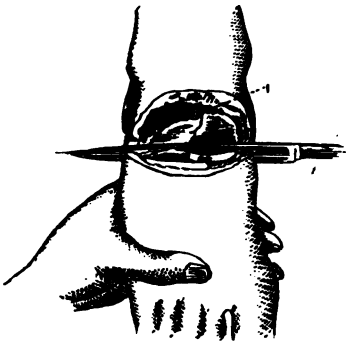
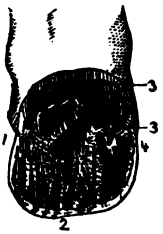


Fig. 165.



vided in this operation are the dorsalis pedis in the dorsal flap, and the plantar arteries in the plantar flap. The tendons are retrenched, and the plantar is attached to the dorsal flap by means of sutures.

In this operation attention is directed to the importance

of making the lateral incisions low down upon either side, so as to pass the knife readily under the bones, and of giving an oval shape to the border of the plantar flap. In seeking the line of the articulation, it is desirable to avoid getting too far back, and equally desirable to avoid advancing so far forward as to get between the scaphoid and cuneiform bones. The convex and rounded articulating surface of the astragalus is to be distinguished from the articulating surface of the scaphoid, which shows three distinct impressions, which receive the articulating surfaces of the three cuneiform bones.

Amputation at the Tibio-tarsal Articulation. *By the flap method* (Syme's operation).

Bones.—The bones entering into the formation of the articulation are the lower extremity of the tibia on the inside, terminating in the internal maleolus, and the lower extremity of the fibula on the outside, terminating in the external malleolus, embracing the broad trochlear surface of the astragalus, and forming a true ginglymoid joint free from lateral motion.

Ligaments.—The ligaments of the articulation are the anterior, the internal lateral or deltoid, and the external lateral, consisting of three fasciculi. The transverse ligament of the tibia and fibula supply the place of a posterior ligament to the joint.

Lines of incision: First.—From the centre of the outer malleolus, downward and across the sole of the heel, in a straight line; then upward to a point on the same level of the opposite side, a slight distance below the inner malleolus (Figs. 166, 167).

Second.—An incision across the instep, connecting the points of the first incision.

OPERATION.—The leg being supported, and the foot placed at right angles to the leg, an incision should be made with the scalpel from one malleolus to the other, across the heel, dividing the structures to the bone, in the line indicated. The anterior incision across the instep should be next made, and the posterior flap dissected from the surface of the os calcis, the knife being kept in close contact with the bone, so as to avoid wounding the bloodvessels and transfixing the flap (Fig. 168.) This can be accomplished by placing the fingers of the left hand upon the heel, the thumb resting upon the edge of the integument, and keeping the knife between the thumb-nail and the surfaces of the bone, at the same time pressing back the tissues as they are detached. The tendo Achillis, when exposed, should be divided, and disarticulation effected by cutting into the joint on the dorsum, and the

Fig. 166.

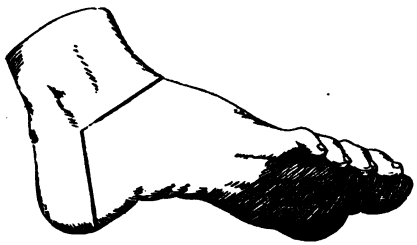
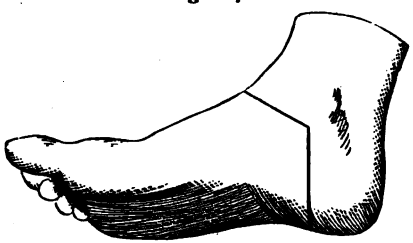


Fig. 167.



sides of the foot at the margin of the anterior flap. The tissues are dissected upward so as to expose the malleoli fully, the knife carried around so as to divide the periosteum, and the saw applied, removing a thin slice of the tibia with the two malleoli.

Fig. 168.

The arteries divided in this operation and requiring ligation are the dorsalis pedis on the dorsal surface, and the two plantar. The tendons having been retrenched, the posterior is to be placed in apposition with the anterior flap and secured by sutures, and an opening made in the posterior flap to secure drainage.

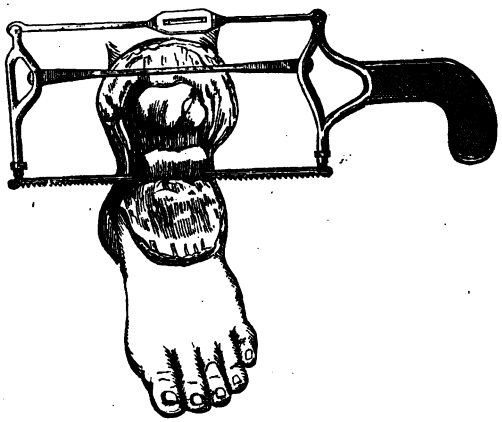
In performing this operation, the student should bear in mind the importance of keeping the knife close to the bone in dissecting off the posterior flap, in order to avoid wounding the vessels which nourish the tissues, and also to avoid puncturing the flap, which, where it is in contact with the tendo Achillis, is very thin and closely adherent.

Amputation at the Tibio-tarsal Articulation (Pirogoff's operation).

This operation is a modification of Syme's method, and consists in leaving the posterior portion of the os calcis in the heel flap, and placing it in apposition with the surfaces of the tibia and fibula, the articulating surfaces of which have been removed.

OPERATION.—The incisions, in this operation, are made in the same manner as in Syme's operation. The articulation is opened from the front, and the lateral ligaments divided, thus disarticulating the head of the astragalus. A small narrow-bladed saw, or a saw such as is used in excisions, is placed obliquely upon the os calcis behind the astragalus, exactly upon the lesser process of the bone, or

Fig. 169.



sustentaculum tali, and section of the bone is made following the line of incision in the soft structures (Fig. 169).

The malleoli are next exposed and removed by the saw, the tendons are retrenched, and the posterior flap containing the segment of the os calcis is now brought up and attached to the anterior flap, placing the bony surfaces in apposition.

The direction given to the line of section of the os calcis in this operation is a matter of importance, in order that the bones may be brought accurately into apposition. Care should be taken to avoid making the section too oblique, and also in beginning the section too near the astragalus.

Amputations of the Leg. SURGICAL ANATOMY.—The leg is that portion of the lower extremity which extends from the thigh to the foot, and may be divided into the upper, middle, and lower third.

Bones.—The bones which enter into its formation are the Patella, the Tibia, and the Fibula.

The *Patella* is a large sesamoid bone placed in front of the knee-joint. Its purpose is to protect the front of the joint and to increase the leverage of the extensor quadriceps femoris muscle.

The *Tibia* is a large prismoidal-shaped bone placed on the inside of the leg, entering by an expanded upper extremity into the formation of the knee-joint, and below into the ankle-joint by its lower extremity, the internal malleolus. It presents on its anterior surface a sharp crest which lies subcutaneous its entire extent.

The *Fibula* is a long slender bone occupying a position on the outside of the leg, articulating by its upper extremity with the tibia, and below terminating in the outer malleolus, which forms part of the ankle-joint.

Ligaments.—The tibia and fibula are united by the interosseous ligament, and are connected to the astragalus below by the ligaments already described (page 209).

Muscles.—On the inner side of the anterior surface the tibia is placed, its crest being subcutaneous. In the middle and on the outer or fibular side of this surface the tibialis anticus, extensor proprius pollicis, extensor longus digitorum, and peroneus tertius muscles are situated. Two layers of muscles occupy the posterior surface; the gastrocnemius, soleus, and plantaris muscles being superficial and forming the "calf." The deep layer consists of the popliteus, flexor longus pollicis, flexor longus digitorum, and tibialis posticus. On the fibular surface the peroneus longus and brevis are placed.

Bloodvessels.—The anterior and posterior tibial and the peroneal arteries pass down on the anterior and posterior surface of the leg, the anterior tibial lying on the anterior surface of the interosseus ligament until it reaches the lower part of the leg, while the posterior tibial and peroneal arteries rest upon the posterior surface of the posterior tibial muscle.

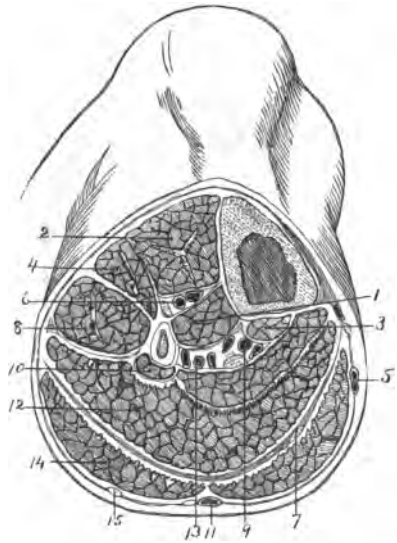
Nerves.—The anterior tibial and musculo-cutaneous nerves are distributed to the anterior surface of the leg, while the posterior tibial and peroneal supply the posterior and outer surface (Fig. 170).

Amputation may be performed in either the lower, middle, or upper third of the leg, and by the circular, oval, rectangular, single or double flap methods. The circular and rectangular methods are best adapted for the lower third, the modified circular or flap methods are preferable in the middle and upper third. Amputation of the leg should never be performed above the tubercle of the tibia or the points of insertion of the biceps, semi-tendinosus, and semi-membranosus muscles, which are necessary in controlling the movements of the stump. The point of

election, or the most desirable point for removal of the leg, is from two to two and a half inches below the tuberosity of the tibia.

Fig. 170.

1. Tibialis posticus muscle
2. Tibialis anticus muscle
3. Flexor longus digitorum.
4. Extensor longus digitorum.
5. Internal saphenous vein
6. Anterior tibial vessels and nerve.
7. Tendon of the plantaris muscle.
8. Peroneus longus muscle
9. Posterior tibial vessels and nerves.
10. Flexor longus pollicis.
11. External saphenous vein and nerve.
12. Soleus muscle with fibrous intersection.
13. Peroneal vessels.
14. Gastrocnemius muscle.
15. Communicans peronei nerve.



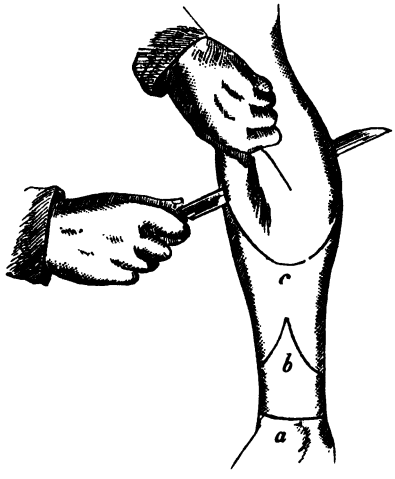
Section of the Right Leg in the upper third, showing structure.

OPERATION: *In the lower third.*—Three to three and one-half inches above the ankle-joint.

By the circular method.—The limb being supported by an assistant, the proximal part is grasped by the left hand of the operator, the skin firmly retracted, and the amputating knife is carried around the limb, making a circular incision (Fig. 171, *a*), dividing the skin and superficial fascia in the manner already described (page 181). The cuff of

skin and fascia is dissected up to the extent of one and one-half to two inches and turned back. Guarding carefully the margin of the retracted cuff, a circular incision is made around the limb at this point, dividing the muscles and other structures to the bones. These, with the periosteum, are dissected back to the extent of an inch or more, and the interosseous membrane divided with the catlin or a large scalpel. A three-tailed retractor is now applied, the middle tail being passed through the interosseous space from below upward and the tissues firmly retracted. The saw, held in a vertical position, should be applied to both bones, drawing it from heel to point and dividing them by short, even strokes, care being taken that the fibula, which is the smaller and most movable bone, should be divided first.

Fig. 171.



The anterior and posterior tibial and peroneal arteries are divided and require ligation. The anterior tibial artery at this point lies in front of the tibia. The posterior tibial and peroneal arteries should be sought for in the

interspace between the soleus muscle behind, and the tibialis posticus muscle in front, the former lying somewhat behind the tibia, and the latter along the inner border of the fibula. The vessels having been ligated, the tendons and nerves retrenched, the cuff is drawn down and the edges approximated by sutures in the transverse or vertical direction.

In amputations of the leg it is desirable to remove the sharp point formed by the crest of the tibia after section. This should be done with the saw or bone pliers, cutting obliquely from above downward.

In the lower third. By the rectangular method (Teale's operation).

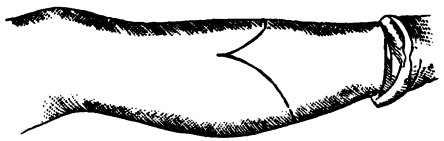
OPERATION.—The lines of incision having been traced out on the limb, the knife is introduced on one side at the point of intended section of the bones and carried downward to a distance equal in length to one-half or one-third the circumference of the limb, dividing all of the structures to the bone (Fig. 148). A similar incision is made on the opposite side, and the two are united by one made transversely across the anterior surface of the leg. The flap, containing the skin and muscular structures, is now dissected up, care being taken to avoid wounding the anterior tibial artery at the base of the flap. The posterior flap, equal in length to one-eighth the circumference of the limb, or one-fourth the length of the anterior flap, is made by a circular incision down to the bone. This flap is dissected up to the requisite extent, the interosseous membrane is divided, the retractor applied, and the bones sawn (Fig. 149). The vessels having been ligated, the tendons and nerves retrenched, the long flap is turned

over the ends of the bones and attached to the short flap by sutures (Fig. 150).

In the middle and upper third. By the double-flap method.—Antero-posterior.

OPERATION.—The limb being supported, the operator grasps the proximal part (placing the thumb and index finger at the points on the outer and inner surfaces of the leg, so as to indicate the breadth of the flap, as well as the point of section of the bone), retracts the skin, and makes a semilunar incision, either with the scalpel or small amputating knife, across the front of the leg from the inner edge of the tibia to the outer edge of the fibula, dividing skin and superficial fascia. This flap, which should be one fourth the length of the posterior and cutaneous in character, is dissected up to the requisite extent, and, the leg being flexed slightly, the amputating knife is entered at the external angle of the first incision and made to transfix the structures on the posterior part of the leg, emerging at a point corresponding on the opposite side of the leg (Fig. 172). In passing the knife, care should be

Fig. 172.



taken to avoid carrying its point *between* the bones. This is likely to occur, unless the operator bears in mind that the edge of the fibula is on a plane posterior to that of the tibia, and, therefore, the handle of the knife should be *elevated* in order to *depress* the point as it passes behind

the bone. The knife, having transfixed the tissues, is carried downward in close contact with the surfaces of the bones, forming a flap of at least four inches in length. The flaps are now drawn back, the remaining structures and interosseous membrane divided, the retractor applied, and the bones sawn.

The anterior and posterior tibial and peroneal arteries will require ligation—possibly some of the larger muscular branches. Sometimes difficulty is experienced in surrounding the anterior tibial artery with a ligature, owing to its retraction above the section of the interosseous membrane upon which it lies. Extension of the limb will frequently cause it to project, so that it can be seized and ligated.

The vessels having been ligated, and the tendons and nerves retrenched, the flaps are approximated by sutures.

By the double-flap method. — Long external and short internal flap (Sedillot's operation).

OPERATION.—The limb being flexed and the foot extended, the skin is elevated over the point of intended section, and the amputating knife is introduced midway between the crest of the tibia and the fibula, and, passing external to the latter, is brought out in the calf of the leg (Fig. 171, *c*). Carrying it downward in close contact with the external surface of the bone, a long external flap is formed. A transverse incision, slightly convex forwards, divides the tissues on the inside of the leg. Dissecting up this flap to the requisite extent, the interosseous membrane is divided, the retractor applied, and the bones sawn as described in the other operations.

Amputation at the Knee-joint. SURGICAL ANATOMY.—The knee is a ginglymoid or hinge-joint, composed of

three bones, the condyles of the femur above, the patella in front, and the upper extremity of the tibia below. The bones are united by fourteen ligaments, anterior, lateral, posterior, and internal, the more important of which are—

The *anterior* or *ligamentum patellæ*, a portion of the tendon of the extensor quadriceps femoris, measuring three inches in length, and extending from the lower border of the patella to the point of insertion in the tuberosity of the tibia.

The *lateral* ligaments are the internal, and the long and short external.

The *posterior*, or the *ligamentum posticum Winslowii*, covers over the entire posterior portion of the joint, and is formed of dense fibrous tissue.

Of the ligaments within the joint, the two *crucial*, anterior and posterior, and the two *semilunar fibro-cartilages*, the internal and external, are the most important in the surgical point of view.

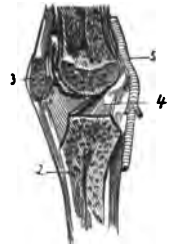
The crucial ligaments are strong interosseous bands attached, below, to the spine of the tibia, and, above, to the outer and inner condyles of the femur, crossing each other as they pass from below upward, the anterior being attached to the front of the spine of the tibia and the inner surface of the outer condyle, and the posterior to the back of the spine and the outer surface of the inner condyle.

The semilunar fibro-cartilages are two crescentic lamellæ attached to the borders of the head of the tibia, and serve to deepen the surface for articulation with the condyles of the femur.

The tendons of the powerful muscles of the thigh, with some of the muscles of the leg, surround and protect it, while important bloodvessels and nerves have intimate relations with the joint (Fig. 173).

The condyles of the femur are two large eminences, into which the lower extremity divides. The external condyle is the most prominent anteriorly, and broadest, while the internal is most prominent internally, and narrowest. It is to be remembered that they are not on the same level, the internal being nearly one-half of an inch lower than the external. The tuberosity on the outer surface of the external condyle is less prominent than that on the internal. The line of the articulation may be described as extending internally from a point three-quarters of an inch above the prominence of the tibia, across the lower border of the patella, and terminating externally three-quarters of an inch below the prominence of the condyle of the femur.

Fig. 173.



Vertical Section of the Knee-joint.

1. The femur.
2. The tibia.
3. The patella.
4. The crucial ligaments.

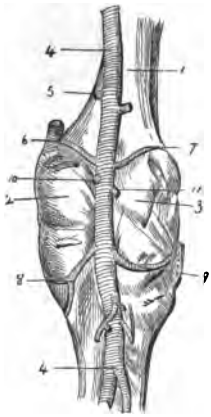
Amputation through the knee-joint may be performed by either the flap, circular, or oval methods. Of the flap methods, that by the long anterior and short posterior is preferred.

Amputation by the long anterior and short posterior flap method, retaining the Patella.

OPERATION.—The knee being flexed, an incision is made, with the scalpel or small amputating knife, from a point on a line with the condyle, near to the border of the popliteal space, across the front of the leg, two and one-half inches below the tubercle of the tibia, to a point corresponding on the opposite side. Dissecting up this flap, the ligamentum patellæ and the lateral ligaments are

divided, opening the joint. The crucial ligaments are next divided, and any remaining portions of the lateral ligaments, thus completely exposing the joint. The amputating knife is now placed behind the head of the tibia, and a short posterior flap is made by cutting downward, keeping the knife in close contact with the bone, care being taken to avoid the head of the fibula. The popliteal artery will require ligation, and possibly several of its branches (Fig. 174). It lies in close contact with the posterior surface of the posterior ligament of the joint, and should be sought for in this position. The tendons and nerves are retrenched, and the anterior flap drawn down over the condyles of the femur, and attached to the posterior by sutures.

Fig. 174.



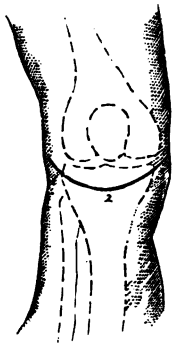
The Popliteal Artery and its Branches in relation with the Knee joint.
1. Femur.
2, 3. Condyles of femur.
4. Popliteal artery.
5, 6, 7. Superior articular branches.
8, 9. Inferior articular branches.
10, 11. Sural branches.

The importance of keeping near to the margins of the popliteal space is to be borne in mind, in order that a flap of sufficient size may be secured to cover the large articulating surfaces of the condyles of the femur.

By the short anterior and long posterior flap. — This method of amputation may also be employed, in which case the patella is removed, and also the condyles of the

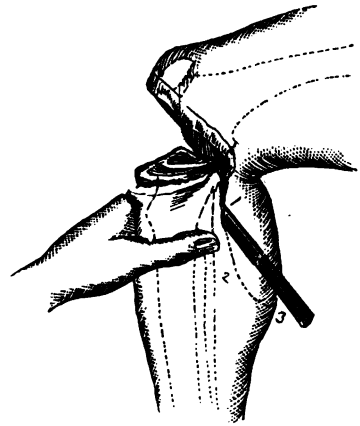
femur, the long flap being taken from the muscles forming the calf of the leg (Figs. 175, 176).

Fig. 175.



Short Anterior and Long Posterior Flap.
1, 2, 3. Line of incision for anterior flap.

Fig. 176.



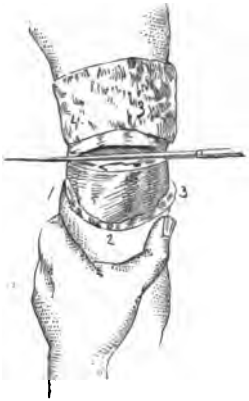
Short Anterior and Long Posterior Flap.
1, 2, 3. Line of incision for posterior flap.

By the circular method.—The circular method may be employed in effecting disarticulation, the first incision being carried around the limb, through the integument, three or four fingers' breadths below the patella. This flap is dissected up to the line of the articulation, and disarticulation effected by division of the ligamentum patellæ, the lateral ligaments, the crucial and, finally, the posterior ligament (Fig. 177). The edges of the flaps are united in either the transverse or vertical direction.

By the oval method (Bauden's method).—This operation is described as follows: The knife is entered three fingers' breadths below the tuberosity of the tibia, cutting

at first transversely, then obliquely upward and around the limb to a point in the popliteal space two fingers' breadths below the line of the joint; the incision passes transversely across the back of the limb, and is continued obliquely

Fig. 177.



Circular Method.

1, 2, 3. Section of integuments.
4, 5. Reflected integuments.

Fig. 178.

The Oval Method.

1, 2, 3. Oblique section of the integuments.
4, 5. Reflected integuments.

downward to its point of commencement. This oval flap is dissected up, and disarticulation effected by dividing the ligaments of the joint (Fig. 178). The vessels are ligated, and the edges of the flap approximated by sutures.

Amputations of the Thigh. SURGICAL ANATOMY.—The thigh is that part of the lower extremity which extends from the pelvis to the leg, and may be divided for the purposes of amputation into the upper, middle, and lower

third. It is larger above than below, and has the shape of an inverted and truncated cone. It is composed of one large bone, numerous large and powerful muscles, blood-vessels, nerves, and lymphatics, and is covered by the integuments, superficial fascia, and a strong aponeurosis (fascia lata).

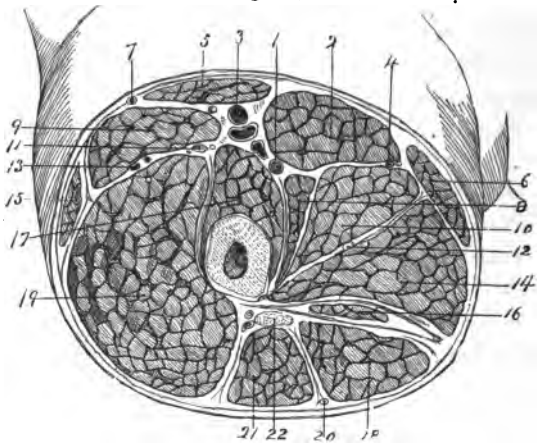
Bone.—The bone of the thigh, the femur, is the largest, longest, and strongest bone in the skeleton. The superior extremity is divided into a globular head which enters into the formation of the hip-joint, a neck varying in length and obliquity, and two prominent processes, the trochanters—the greater on the outside and the lesser on the inside. The inferior extremity terminates in the condyles which form part of the knee-joint.

Muscles.—Large and powerful muscles occupy the anterior, internal, and posterior surfaces of the thigh; on the anterior surface the tensor vaginæ femoris, sartorius and quadriceps extensor femoris, and subcrureus; on the internal surface the gracilis, pectineus and adductors longus, brevis, and magnus; on the posterior surface the biceps, semitendinosus, and semimembranosus. Attached to the inner trochanter is the common tendon of the psoas magnus and iliacus, while to the outer trochanter and upper part of the shaft are the glutei, the pyriformis, the two obturators, the two gemelli, and quadratus femoris.

Bloodvessels.—The femoral artery, and branches of the internal iliac, supply the structures of the thigh; the former in its course down the thigh passes from the anterior to the inner, and then to the posterior surface; the latter escape from the pelvic cavity through the great sciatic foramen, and supply the structures in the region of the hip-joint.

Nerves.—The anterior crural and the great and small sciatic nerves with their branches, are distributed to the structures of the thigh, the former occupying the anterior

Fig. 179.



Section of the Right Thigh at the apex of Scarpa's Triangle, showing structure.

1. Profunda femoris vessels.
2. Adductor longus muscle.
3. Femoral vessels.
4. Superficial obturator nerve.
5. Sartorius muscle.
6. Gracilis muscle.
7. External cutaneous nerve.
8. Pectineus muscle.
9. Rectus femoris muscle.
10. Adductor brevis muscle.
11. Anterior crural nerve.
12. Deep obturator nerve.
13. External circumflex vessels.
14. Adductor magnus muscle.
15. Tensor vaginæ femoris muscle.
16. Semimembranosus muscle.
17. Vastus internus and crureus muscles.
18. Semitendinosus muscle.
19. Vastus externus muscle.
20. Small sciatic nerve.
21. Biceps muscle.
22. Great sciatic nerve.

and inner aspect, and the latter the posterior and outer (Fig. 179).

Amputation may be performed at any point of the limb,

and by either the circular, oval, flap, or rectangular methods. The flap method is that which is usually preferred, owing to the ease with which it is performed and the ample covering it gives to the end of the bone. In performing amputation by the flap method the tendency to powerful retraction on the part of the muscles of the thigh should be remembered, and the flaps made ample in order to avoid the formation of a conical stump.

Amputation in the lower third. By the antero posterior flap method.

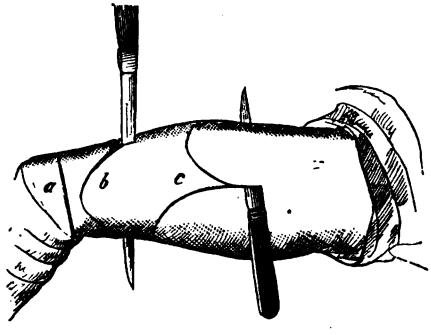
OPERATION.—The tissues on the anterior surface of the thigh being grasped firmly, raised and retracted, the operator enters the amputating knife on the side of the limb nearest to him, carries the point directly to the centre of the bone, depresses the handle, passes the point over the bone and brings it out at a point on the opposite side corresponding to the point of entrance. It is then carried downward in close contact with the surface of the bone to the distance of two to three inches as may be necessary, when its edge is turned and is made to cut its way out in an oblique direction. The knife is re-entered at the original point, carried behind the bone, emerging at the same point as before, and the posterior flap, which should be somewhat longer than the anterior, is formed by cutting downward and then outward as in forming the first flap; a circular sweep is now made around the bone, dividing the remaining tissues, with the periosteum; the latter is dissected up to a short extent, the retractor applied, and the bone sawn through. The arteries divided and requiring ligation are the femoral and some of its muscular branches. The artery is found on the inside under the sartorius, with the vein to the outside.

The flaps are retrenched, if necessary, and united by sutures.

In the lower third. By lateral flaps.

OPERATION.—The tissues on the side of the limb being grasped so as to elevate and retract them, the knife is entered in the vertical direction, carried down to the bone, passing to one side, and emerging on the posterior surface of the thigh at a point exactly opposite that of entrance. It is then carried downward in close contact with the bone, and then outward, forming a flap from three to four inches in length as may be required. The knife is reintroduced at the same point, passed around the bone, and is brought

Fig. 180.



out at the same point on the posterior surface of the limb, and a flap formed as before (Fig. 180, *b*). A circular sweep is made, dividing the remaining structures with the periosteum, the latter is dissected up to a slight extent, the retractor applied, and the bone sawn through. The vessels are ligated, and the flaps united as in the operation by antero-posterior flap.

In the lower third. By the long anterior flap. (Sedillot's operation.)

OPERATION.—Amputation by this method is performed by making a flap from the anterior surface, equal in length and breadth at its free extremity to two-thirds of the circumference of the limb at the point of section of the bone. This flap is made by transfixion, and should not include the artery. A slightly convex incision, dividing structures to the bone, is made on the posterior surface on a level with the base of the long flap. The operation is completed as in other methods.

In the lower third. By the rectangular flap.

OPERATION.—The lines of incision having been traced out on the limb (Fig. 181), two longitudinal incisions are made on either side, beginning at the point of intended section of the bone, and carried downward to such extent

Fig. 181.

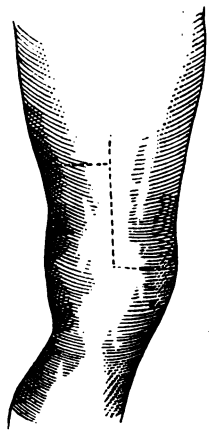
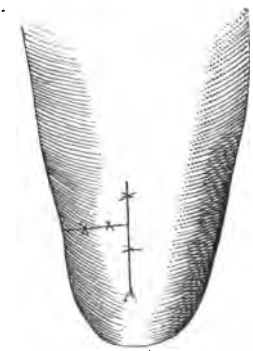


Fig. 182.



as to form a flap measuring in length and breadth from one-third to one-half the circumference of the limb. These incisions are joined at their lower extremities by a transverse incision, and the flap, including all of the structures to the bone, is to be dissected up. The short or posterior flap, containing the vessels and equal in length to one fourth of the long flap, is made by a transverse incision to the bone. This flap is dissected up, and, the retractor having been applied, the bone is sawn through (Fig. 149). The vessels are ligated, and the sutures introduced, uniting the flaps (Fig. 182).

In the lower third. By the circular method.

OPERATION.—Amputation by this method is performed by making a circular sweep around the limb just above the upper margin of the patella (Fig. 180, *a*), dividing the skin and superficial fascia. Firm traction is made by an assistant, with both hands, in order to retract the integuments, and another circular incision is made, dividing the superficial muscles, the posterior being cut somewhat longer than the anterior. Retraction is again made, and the deeper muscles divided, by a circular incision, to the bone. The retractor is applied, the bone sawn, the vessels ligated, and the operation completed by approximating the flap with sutures.

This method of performing the circular operation gives a complete covering to the end of the bone, which forms the apex of a hollow cone, the base being formed by the margins of the integuments.

In the lower third. By the modified circular method.

OPERATION.—By this method, two semilunar flaps, with the convexity downward, consisting of skin and superficial fascia (Fig. 183), are dissected up to the point of section

of the bone, and an incision of the muscles made as in the circular operation just described. The semilunar flaps covering the muscles are united by sutures, as in the flap method.

In the middle third.—Amputation at this point may be performed by any of the methods employed in the lower

Fig. 183.

third. The retraction of the muscles being here less than in the lower third, the flap method can be adopted with advantage (Fig. 180, *c*).

In the upper third, below the trochanters.—At this point amputation by the antero-posterior flap is deemed the most desirable method, and is performed in the same manner as in the middle or lower third.

Amputation at the Hip-joint. SURGICAL ANATOMY.—The hip-joint is an enarthrodial or ball-and-socket joint

formed by the reception of the globular head of the femur into the cup-shaped cavity of the acetabulum, placed on the outside of the os innominatum.

Bones.—The bones which enter into the formation of the joint are the femur and the os innominatum, consisting of the ilium, ischium, and pubes.

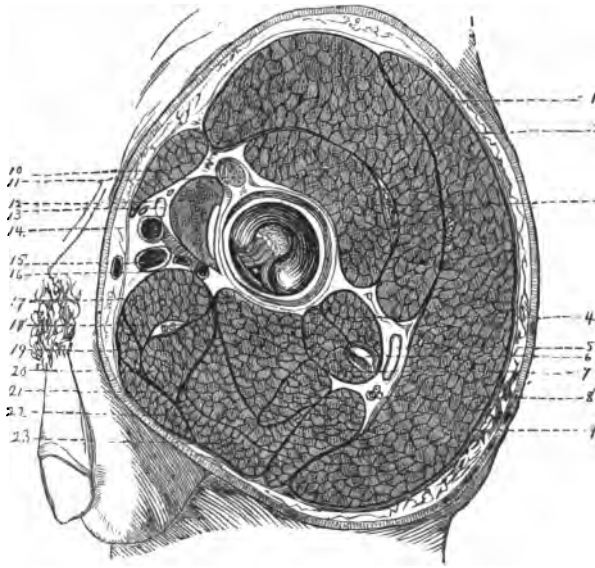
Ligaments.—The principal ligaments of the joint are the *capsular*—ilio-femoral and teres; the *cotyloid* is a fibro-cartilaginous rim which serves to deepen the cavity of the acetabulum, and the *transverse* is placed across the acetabular notch, converting it into a foramen. The *capsular* is a strong, dense ligament which envelops the joint, being attached above to the margin of the acetabulum, and below, around the base of the neck of the femur. The *ilio-femoral* is a re-enforcing or an accessory ligament extending obliquely across the front of the joint. The *teres* ligament consists of a triangular band of fibres, the apex of which is inserted in a depression placed on the head of the femur *a little behind and below its centre;* the base is attached to the margins of the notch on the floor of the acetabulum.

Muscles.—The joint is surrounded on all sides by large, strong muscles which cover and protect it. They take their origin in general from the different parts of the pelvis adjacent to the articulation, and are attached to the trochanters and upper portions of the shaft of the femur. They have been named in connection with the muscles of the thigh.

Bloodvessels.—The bloodvessels which supply the joint are derived from the obturator, sciatic, internal circumflex, and gluteal arteries. The femoral artery passes in front of the articulation, separated by the capsular ligament and

the inner margin of the psoas magnus muscle, upon which it rests.

Fig. 184.



Section through the Hip-joint and Gluteal region.

1. Glutæus maximus muscle.
2. Glutæus medius muscle.
3. Glutæus minimus muscle.
4. Pyriformis muscle.
5. Great sciatic nerve and vessels.
6. Tendon of obturator internus muscle.
7. Gemelli muscles.
8. Biceps muscle.
9. Quadratus femoris muscle.
10. Sartorius muscle.
11. Reflected tendon of the rectus muscle.
12. Psoas and iliacus muscles, with bursa.
13. Anterior crural nerve.
14. Common femoral artery.
15. Common femoral vein.
16. Profunda artery.
17. Gracilis muscle.
18. Semimembranosus muscle.
19. Adductor brevis muscle.
20. Semitendinosus muscle.
21. Obturator externus muscle.
22. Adductor longus muscle.
23. Adductor magnus muscle.

Nerves.—Branches from the sacral plexus, the great sciatic, obturator, and accessory obturator supply the joint (Fig. 184).

The articulation being placed deeply beneath the muscular and other structures, and therefore difficult to reach by manipulation, it is important to establish the positions and relations of certain fixed points. Bernard and Huette give the following guides to the articulation, which should be borne in mind in operations upon the joint.

1. The anterior inferior spinous process of the ilium is three-quarters of an inch above the superior margin of the acetabulum: the anterior superior spinous process is about an inch and three-quarters above the same point, and three-quarters of an inch to its outer side.

2. The subject being erect, a line drawn from the anterior superior spinous process of the ilium to the tuberosity of the ischium, crosses the acetabulum at the junction of its posterior with its two anterior thirds.

3. The anterior border of the acetabulum is from an inch to an inch and a quarter to the outer side of the spine of the pubes.

4. The axis of the horizontal ramus of the pubes, extended by an imaginary line, crosses the acetabulum at the junction of its superior with its middle third.

5. The superior border of the trochanter major is on a level with the upper third of the cavity of the joint (Fig. 185).

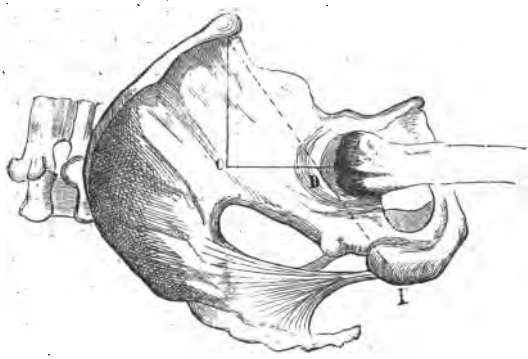
As the capsular ligament is attached around the borders of the acetaculum, it is desirable, in order to divide the ligament readily and open the joint, to carry the knife around the margin of this cavity. In doing this, it should be remembered that the acetabulum projects further over

the head of the femur posteriorly than it does anteriorly, and the knife, therefore, when applied posteriorly, should be carried obliquely from behind forward and inward.

Amputation at the hip joint may be performed by the flap method, single or double, antero-posterior or lateral, the oval, and the circular methods.

By the single anterior flap.—The patient being placed upon the table, with the hip projecting, the limb flexed on the pelvis, and separated from its fellow, the operator takes a position on the outside of the limb, raises the soft structures on the anterior surface with his left hand, and

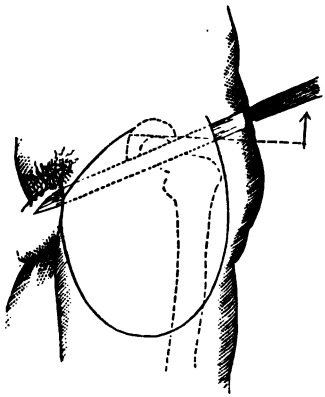
Fig. 185.



enters the point of a long amputating knife midway between the anterior superior spinous process of the ilium and the great trochanter, and carries it to the articulation. Elevating the handle slightly, the point is carried over the articulation, transfixing the capsule as it passes, and is brought out at a point one inch below and in front of the tuberosity of the ischium, care being taken to avoid wound-

ing the scrotum, which should be held out of the way by an assistant (Fig. 186). The knife, kept in close contact with the bone, is carried downward, forming a flap six inches long, both sides being of equal length. The flap is now raised, and the artery, which it contains, compressed by an assistant. With a large scalpel, the capsule of the joint is now divided on its anterior and inner surface, and the limb abducted and rotated outward by an assistant, so as to expose the insertion of the ligamentum teres into the head of the femur. This is divided, when the head of the bone can be luxated and the posterior portion of the capsular ligament divided. The heel of the amputating knife is now placed behind the trochanter major, the point projecting as before, and the structures forming the posterior portion of the thigh are divided in a vertical direction. If desirable, this last incision can be made from without inward by a circular sweep of the knife, as in the circular method.

Fig. 186.



The vessels which are divided, and require ligation, are the femoral, obturator, sciatic, external and internal circumflex.

The long anterior flap is drawn downward, and united by sutures to the posterior.

By the double-flap method: Antero posterior.—In amputation by this method, the anterior flap is formed in the same manner as in the single anterior flap operation, the length being from three to four inches (Fig. 187). After the ligaments of the joint have been completely severed, the amputating knife is placed behind the great trochanter, and the posterior flap, of the same length as that of the anterior, is made from the tissues on the back of the thigh (Figs. 188, 189). The

Fig. 187.

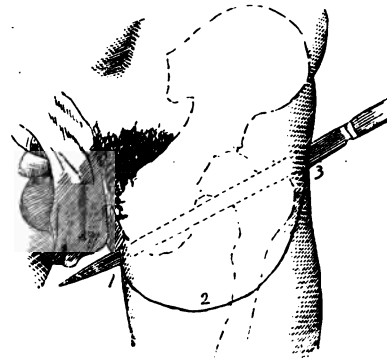


Fig. 188.

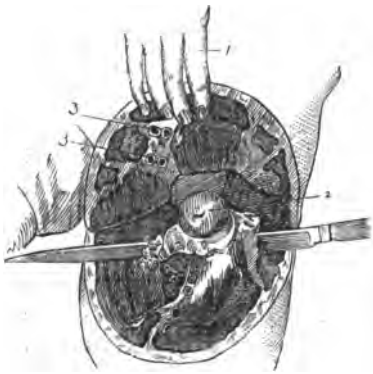
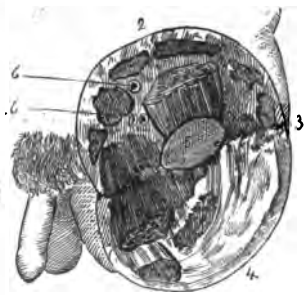


Fig. 189.



vessels are ligated, and the flaps, having been retrenched, if necessary, are united by sutures.

By the double lateral flap method.—The patient being placed on the table, with the hip projecting beyond the edge, a long amputating knife is entered at a point midway between the anterior superior spinous process of the ilium and the great trochanter, and pushed downward around the head of the femur on the outer side, and made to emerge immediately below the tuberosity of the ischium (Fig. 190). The tissues over the great trochanter are

Fig. 190.

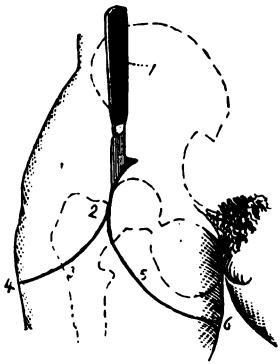


Fig. 191.

drawn outward, and the knife is carried downward and outward around the great trochanter, in close contact with the bone, forming a flap four inches in length. The knife is reintroduced at the lower angle of the wound, its point carried directly upward around the neck of the femur, and brought out at the upper angle. The tissues on the inside of the thigh are now drawn inward, and the knife is carried

downward around the lesser trochanter, in close contact with the bone, forming a flap of the same length as that on the outside (Fig. 191). This flap is raised, and the femoral artery grasped by an assistant. Disarticulation is effected by dividing the capsular ligament at the inner and upper part of the joint, next the ligamentum teres, the limb having been abducted and rotated outward in order to expose its point of insertion into the head of the femur, and finally completing the disarticulation by dividing the remaining portion of the capsular ligament. The vessels are ligated, the flaps placed in apposition, and united by sutures, as before described.

By the oval method.—The position of the femoral vessels having been definitely ascertained, the patient is placed upon the sound side and the point of the knife entered above the great trochanter and an oblique incision made backward, outward, and downward, to a point below the tuberosity of the ischium. The knife is re-entered at the upper angle of the wound and an incision carried forward, inward, and downward, terminating at a point just above the position of the femoral vessels. The muscles on the outer side, which are attached to the great trochanter, are divided, exposing the capsule of the joint; this is divided externally, and the knife, being carried to the inner side, divides the ligamentum teres as the limb is rotated outward. Disarticulation is completed by cutting the remaining portion of the capsular ligament, and the knife, being placed behind the bone, divides the remaining structures by a transverse incision. The vessels are ligated and the flaps approximated by sutures so as to form a linear incision.

By the circular method.—Amputation at the hip-joint by this method is performed by making a circular incision,

dividing the skin and superficial fascia three to three and a half inches below the great trochanter. The skin flap is dissected up and a circular sweep of the knife is made, using great force and dividing the muscles to the joint. Disarticulation is effected, and the operation completed by ligating the vessels and approximating the flap in a direction slightly oblique.

By the modified circular method—Double skin flaps and circular division of the muscles (Skey's operation).—In this method of amputation the knife is entered one inch below the anterior superior spinous process of the ilium and carried down in a vertical direction for an inch and a half; it is then carried inward, following nearly the line of Poupart's ligament and about four inches below it, and terminates by a gentle curve, at a point about two inches below the tuberosity of the ischium. The second incision begins at the end of the vertical incision and is carried on the outer side of the thigh, crossing the shaft of the femur immediately below the trochanter major and, passing circularly backward, terminates at the same point as the first incision. The flaps being dissected up to the highest extent, the muscles are divided by a circular sweep of the knife, applied with great pressure. The joint being exposed, the ligaments are divided and disarticulation effected. The operation is completed by ligating the vessels and approximating the skin flaps.

In amputations of the lower extremity the arterial circulation may be controlled by digital compression of the femoral artery immediately below Poupart's ligament. It may also be controlled in the middle third of the thigh by placing a compress over the artery beneath the tourniquet and applying the pressure so as to compress the vessel

on the inner side of the shaft of the femur. Esmarch's bandage may be applied, carrying the turns to the hip-joint, and thus controlling the circulation in operations at any point of the extremity. In amputations at the hip-joint, pressure may be made over the artery beneath Poupart's ligament, or an abdominal tourniquet may be applied compressing the aorta.

UPPER EXTREMITY.

Amputations of the Hand. SURGICAL ANATOMY.—The hand is the terminal part of the upper extremity, and is divided into three portions—the carpus or wrist, metacarpus or palm, and the phalanges or fingers.

Bones.—The *carpus* consists of eight bones arranged in two rows; the first row contains the scaphoid, semilunar, cuneiform and pisiform; the second row, the trapezium, trapezoid, os magnum, and unciform, enumerated from the radial to the ulnar side.

The *metacarpus* is composed of five bones and, like the bones of the metatarsus, are classified as long bones.

The *phalanges* are fourteen in number—two for the thumb and three for each finger.

Ligaments.—The carpal bones are attached to each other in the rows by dorsal, palmar, and interosseous ligaments, and the two rows are bound together by dorsal, palmar, external and internal lateral ligaments. With each other an arthrodial joint is formed; between the two rows an enarthrodial articulation exists. The carpus and the four inner metacarpal bones are connected by dorsal, palmar, and interosseous ligaments, while the articulation of the metacarpal bone of the thumb with the trapezium is enarthrodial in character, the two bones being united by a

capsular ligament. The metacarpal bones are connected together by dorsal, palmar, and interosseous ligaments, and with the phalanges by anterior and two lateral ligaments.

The phalanges are united by anterior and two lateral ligaments. The articulations between the metacarpal bones and the phalanges, and between the phalanges, are true ginglymoid joints, and are lined by synovial membranes.

Muscles.—In addition to the tendons of the flexor muscles, which are inserted into the phalanges of the thumb and fingers, there are three groups of muscles placed on the palmar surface, and connected, respectively, with the thumb, little finger, and the palm.

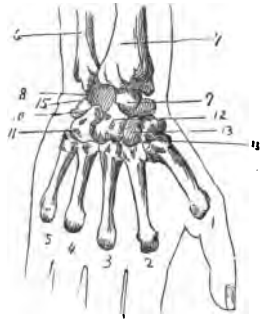
On the dorsal surface the extensor tendons pass to their insertions into the bones of the thumb and fingers, while the interossei fill up the spaces between the metacarpal bones.

Articulations.—The articulations of the phalanges of the hand with each other, and with the metacarpal bones, present the regular lines which are observed in the phalanges of the foot. Between the metacarpal and carpal bones, the line of articulation is quite irregular, resembling in character, but in less marked degree, the irregularity of the line of articulation between the metatarsal and tarsal bones of the foot.

In the hand the second metatarsal bone is wedged in between the trapezium on the radial and the os magnum and base of the third metacarpal bone on the ulnar side, and the trapezoid behind. In amputation at the carpo-metacarpal articulation, or in excision of the second metacarpal bone, this position of the head of the second metacarpal bone should be borne in mind.

The line of articulation between the two rows of carpal bones is quite irregular, owing to the projection downward of the scaphoid bone, placing thus the line of junction between the semilunar and os magnum nearly one-half of an inch above. From this point the line between the cuneiform and unciform is oblique, terminating at a point nearly one-quarter of an inch above the point of articulation on the opposite side (Fig. 192).

Fig. 192.



1–5. Metacarpal bones.
6. Ulna.
7. Radius.
8–15. Carpal bones.

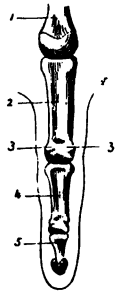
Bloodvessels. — The structures of the hand are supplied by the radial and ulnar arteries and their branches, which form arches on the palmar and dorsal surfaces, and from which interosseous and digital branches are given off. The superficial palmar arch lies upon the anterior annular ligament, in front of the tendons of the flexor muscles and the median and ulnar nerves, while the deep arch rests upon the carpal extremities of the metacarpal bones. To the thumb and each finger four branches are distributed, placed on the sides, anteriorly and posteriorly.

Nerves.—The palmar surface of the hand and fingers is supplied by the median and ulnar nerves and their branches, the digital branches accompanying the digital arteries in their distribution to the fingers. The radial and ulnar nerves, with their branches, are distributed to the posterior surface of the hand and fingers, following the course of the arteries.

In amputations of the hand, it is of the utmost importance that the operation should be performed in such manner as to save as much of the organ as possible. Every portion is of value to the patient, and can be made useful by him. Great care and discretion should therefore be exercised by the surgeon when called upon to perform amputations upon this part. A thumb and a little finger, or a thumb alone, or a little finger alone, if saved, will render better service than any artificial appliance which can be made.

Amputations of the Fingers. *Methods.*—At the phalangeal articulations or in the continuity of the bones, amputation may be performed by either the *flap* or *circular* methods. At the metacarpo-phalangeal articulation, the *oval* method is best adapted.

Fig. 193.



1. Lower extremity of metacarpal bone.
2. First phalanx.
3. Head of first phalanx.
4. Second phalanx.
5. Third phalanx.

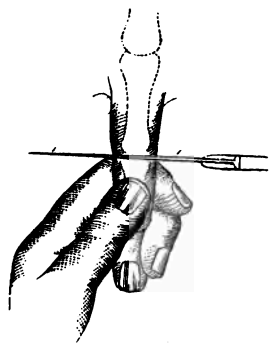
In performing amputation through the articulations of the fingers, it is important to establish the relations to the joint of certain fixed and constant surface markings which exist upon the palmar and dorsal surfaces. Upon the palmar surface three distinct transverse linear depressions are observed, which, with the finger in extension, have the following relation to the corresponding articulations: that at the commissure of the fingers is about one inch below the metacarpo-phalangeal articulation; the middle depression

that between the first and second phalanges is exactly over the joint; and the third is about a line and a half beyond the articulation, between the second and third phalanges (Fig. 193). When the finger is in a state of extreme flexion, the relations of these depressions to the articulations change (Fig. 194).

Fig. 194.

On the dorsal surface, the positions of the articulation with the finger in extension are indicated by distinct depressions, which can be felt in making deep pressure over the joints. The line of the articulation is immediately behind the bony projections which are placed on the sides of the phalanges at their proximal extremities. When the finger is in extreme flexion the distal extremities of the metacarpal bone and phalanges present forward and the line of the articulation is placed *below* the projecting extremity (Fig. 194).

Fig. 195.



OPERATION: *Through the articulation. By the single flap method.*—Having ascertained the position of the joint, the finger is strongly flexed so as to prominently display the line of articulation, and a strong bistoury with a narrow blade is made to enter the joint by a transverse incision extending from one side

to the other (Fig. 195); the lateral ligaments are now divided, completely opening the joint, and the blade of the bistoury is introduced behind the head of the bone (Fig. 196); keeping it in close contact with the bone, it is carried downward, forming a palmar flap of sufficient length (Fig. 197).

Fig. 196.

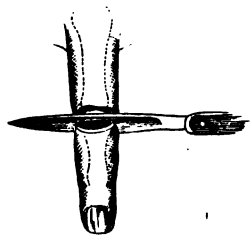
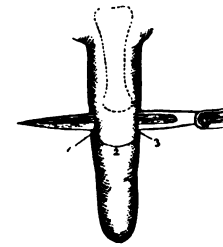


Fig. 197.



The digital arteries may require ligation. Retracting the tendons, the palmar flap is brought upward over the end of the phalanx and attached by suture to the dorsal flap.

By the double flap method.—A semilunar incision is made across the dorsum of the finger, the points of origin and termination being over the articulation at the sides. The flap is dissected up, disarticulation effected, and a flap of equal length is made from the palmar surface of the finger by carrying the knife downward in close contact with the bone. The vessels are secured, the tendons retrenched, and the flaps united by suture.

By the circular method.—Amputation by this method may be performed by making a circular incision around the finger from one-quarter to one-half of an inch below the line of the joint. The skin is retracted and disarticu-

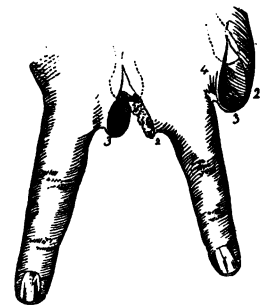
lation effected by division of the ligaments. The vessels are ligated, tendons retrenched, and the skin flap is drawn over the head of the bone and the edges approximated in the transverse direction.

Amputation in the Continuity of the Phalanges. OPERATION.—Amputation in the continuity of the phalanges may be performed by either the circular, flap, or rectangular flap methods, the incisions being made as at the articulations and the bone divided by the small saw or bone pliers.

Amputation at the Metacarpo-phalangeal Articulation.—Amputation at this articulation may be performed by either the oval, lateral, flap, or circular methods.

OPERATION: *By the oval method.*—Fixing the position of the articulation, and flexing the finger at an angle of forty-five degrees, the incision is commenced one-quarter of an inch above the line of the joint on the dorsal surface and carried down to the commissure. Forcibly extending the finger, the incision is continued across its base in the fold of the skin, and thence upward to the point of origin. Dissecting up the skin and fascia, disarticulation is accomplished by dividing the extensor tendons and lateral ligaments, luxating the head of the phalanx and dividing finally the flexor tendons (Fig. 198). The arteries should be ligated if necessary, the tendons retrenched, and the flaps united by sutures.

Fig. 198.



By the lateral flap method. — In this method the lateral flap is formed by carrying an incision from a point over the articulation obliquely downward to the side of the finger a short distance in front of the web, thence backward to a point on the under surface of the articulation. An incision of a similar character is made on the other side of the finger, uniting with the first incision at its termination. The flaps are dissected up and disarticulation effected as in the oval operation (Fig. 198).

By the circular method.—Amputation by this method is performed by making a circular incision around the finger on a line with the fold of the skin on the palmar surface. Retracting the skin and fascia, a second incision is made, dividing the soft structures to the bone; these are drawn up and disarticulation is effected as in the other methods.

Amputation of the Little Finger at the Metacarpophalangeal Articulation. *By the oval method.*

Fig. 199.

Fig. 200.

OPERATION.—The little finger can be removed by the oval method, the incision being made on the side above the articulation in preference to the dorsal surface, as on the index finger, the incision extending upward so as to remove the metacarpal bone if required (Figs. 199, 200).

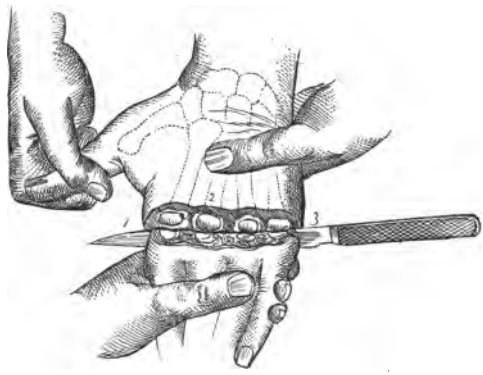
Amputation of the Index Finger at the Metacarpo-phalangeal Articulation.—*By the oval method.*

OPERATION.—Amputation of the index finger at the metacarpo-phalangeal articulation may be performed by the oval method, the incision beginning on the side in preference to the dorsal surface, thus forming a more shapely stump.

Amputation of all of the Fingers at the Metacarpo-phalangeal Articulation. *By the single flap method.*

OPERATION.—The fingers, slightly flexed, are grasped by the operator, the integument firmly retracted, and a slightly curved incision is made from one-half to three-

Fig. 201.



quarters of an inch below the heads of the metacarpal bones. The extensor tendons are now exposed and divided; each articulation is opened and disarticulation completed by dividing the lateral and palmar ligaments. The knife is placed behind the heads of the phalanges (Fig. 201), and a flap is formed by carrying it downward and terminating the incision at the base of the fingers (Fig. 202). The digital arteries are to be ligated, the tendons retrenched, and the palmar flap drawn over the ends of the bones, which may be removed by the pliers if deemed necessary, and attached by means of sutures.

Fig. 202.

By the circular method. — The integument having been firmly retracted, a circular incision is carried around the base of the fingers, following the depressions in the skin at the commissures. The divided tissues are drawn back and disarticulation effected as in the flap method.

Amputations of the Thumb — at the Metacarpo-phalangeal Articulation.

OPERATION. — Amputation of the thumb at the metacarpo-phalangeal articulation may be performed by either the flap, circular, or oval methods, as in the fingers. In performing the operation care should be taken to remove the sesamoid bones connected with the metacarpal bone, and to make the flaps ample in order to cover the digital extremity of the bone, which is broad from side to side.

By the single flap method.

OPERATION. — Amputation of the thumb at the carpo-metacarpal articulation by this method may be performed

by carrying an incision from before backward through the middle of the commissure between the thumb and index finger, the former being abducted, and terminating it at the articulation. Disarticulation is now effected and the external flap is formed by introducing the knife behind and carrying it, in close contact with the bone, to a short distance below the metacarpo-phalangeal articulation. The radial artery may be avoided if the knife, in the first incision, is kept in close contact with the bone at the upper extremity. If divided, the artery with the digital branches should be ligated and the edges of the flaps united by sutures.

By the oval method.—This operation may be performed by making an incision over the articulation between the trapezium and metacarpal bone, carrying it downward to the point of junction of the web with the thumb, across

Fig. 203.

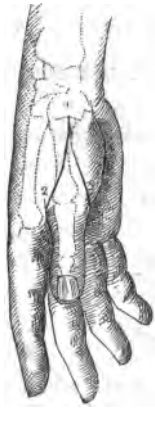


Fig. 204.

the base of the thumb, and then back to a point at the middle of the first incision (Fig. 203). Keeping the knife close to the bone, and separating the tissues carefully, the joint is opened on the dorsal surface, and disarticulation completed by dividing the remaining ligaments. The digital arteries are ligated, and the flap united so as to form a linear incision (Fig. 204).

Amputation in the Continuity of the Metacarpal Bones. *By the flap method.*

OPERATION.—In performing this operation, a curved incision is made across the dorsum of the hand from one side to the other, dividing the structures to the bone. This flap is dissected up, and a flap is made from the palmar surface in the same manner, or by transfixion. The periosteum and interosseous tissues are divided, and a five-tailed retractor applied. The bones are sawn through, vessels ligated, tendons retrenched, and the flaps united by sutures.

Amputation through the Carpo-Metacarpal Articulation, leaving the Thumb. *By the single flap method.*

OPERATION.—The hand being in a position of supination, a small straight knife is entered on the inner border of the hand, at the point of junction of the unciform with the fifth metacarpal bone, and carried obliquely across the palm so as to emerge at a point just below the thumb (Fig. 205). The knife is now carried downward in contact with the bones, and a large convex flap made from the palm. Placing the hand in the prone position, a semicircular incision is made across the dorsum, two-thirds of an inch below the line of the articulation, and carried inward and

downward, dividing the tissues connecting the thumb and index finger, and joining the first incision (Fig. 206). The flap being retracted, disarticulation is effected by

Fig. 205.

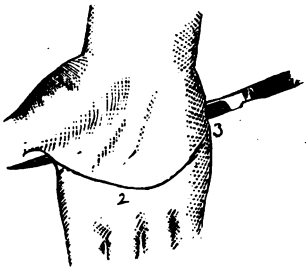


Fig. 206.

dividing the ligaments, beginning on the palmar surface. The radial and ulnar arteries, with, possibly, some of their branches, will require ligation. The tendons are retrenched, and the palmar flap is drawn upward and attached to the dorsal by suture.

Amputation at the Wrist-joint. SURGICAL ANATOMY.—The wrist-joint unites the forearm and carpus, and, with the exception of rotation, possesses all of the characteristic movements of an enarthrodial articulation.

Bones.—The bones which enter directly into the formation of the articulation are the radius of the forearm, and the scaphoid and semilunar of the carpus (Fig. 192). The ulna and cuneiform bones participate indirectly, being separated by the intervening articular fibro-cartilage.

Ligaments.—The ligaments of the joint are the external and internal lateral, and the anterior and posterior. The lateral ligaments are attached above to the styloid processes of the radius and ulna, and below to the subjacent carpal bones and annular ligament. The anterior ligament, a broad membranous band, extends from the margins of the lower extremities of the bones of the forearm to the three carpal bones below, thus uniting all of the bones which enter into the formation of the joint. The posterior ligament, less thick and strong, is attached above to the radius, and below to the scaphoid, semilunar, and cuneiform bones.

Muscles.—The tendons of the flexor muscles pass in front of the joint, and the tendons of the extensor muscles behind.

Bloodvessels.—The anterior and posterior carpal branches of the radial and ulnar arteries, with the anterior and posterior interossei and branches from the deep palmar arch, supply the joint.

Nerves.—The nervous branches which are supplied to the joint are derived from the ulnar.

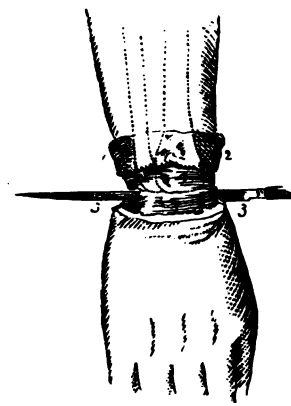
Line of the articulation.—The line of the articulation is curved, owing to the convex surfaces presented by the union of the three carpal bones, which are received into the concave surfaces of the radius and ulna. The marked projections formed by the styloid processes of the radius and ulna are guides to the position of the articulation. It is to be remembered, however, that the styloid process

of the radius projects downward about one-sixth of an inch below that of the ulna. The articulation lies from a sixth to a fourth of an inch above a line passing through the extremities of the two styloid processes, the position of which is further indicated by the middle fold of skin on the palmar surface of the wrist.

Amputation at the wrist joint may be performed by either the circular or the flap method.

OPERATION: *By the circular method.* — The forearm being held in a position midway between supination and pronation, a circular incision is made around the limb about an inch below the styloid processes, dividing the skin and fascia. The cuff of skin and fascia being dissected up and turned back to a point above the line of the articulation, a second circular incision is made, dividing the remaining structures to the joint (Fig. 207). Disarticulation is effected by carrying the knife on the posterior part along the curve of the carpal bones, the hand being forcibly flexed. The styloid processes of the radius and ulna may be sawn off on a level with the encrusting cartilages. The radial, ulnar, and interosseous arteries will require ligation. The tendons of the flexor and extensor muscles should be retrenched, and the edges of the flap approximated in the transverse direction.

Fig. 207.



By the single flap method.—The hand being held in a prone position, a slightly convex incision is made from one styloid process to the other across the back, dividing the structures to the bone. The skin is retracted and the joint opened on the dorsal surface. Disarticulation being effected, the amputating knife is placed behind the bones of the carpus (Fig. 208), and carried downward in close contact with them, forming a flap of sufficient length from the anterior surface of the palm (Fig. 209). The styloid

Fig. 208.

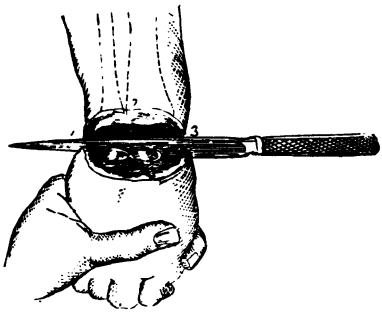


Fig. 209.

processes are sawn off, if necessary, the vessels ligated, tendons retrenched, and the long flap drawn upward over the surface of the bones, and united to the posterior flap by sutures.

By the double flap method.—The hand being slightly flexed, a convex incision extending from one styloid process to the other is made, first on the dorsal, and then on the palmar surface of the hand, forming two flaps, each one inch and a half in length. These flaps are dissected up to the joint, disarticulation performed, and the operation completed as in the previous methods.

Amputation of the Forearm. SURGICAL ANATOMY.—The forearm is that part of the upper extremity comprised between the arm and the hand, and is composed of two bones, muscles, with bloodvessels, nerves, and other structures.

Bones.—The bones of the forearm are two in number, the radius and ulna—the former placed on the outside and the latter on the inside. The ulna is the largest and longest of the two; its upper extremity is thick and strong, firmly fixed in its position, and enters, by the olecranon process, largely into the formation of the elbow-joint. The lower extremity is small, movable, and, owing to the interposition of the articular fibro-cartilage, does not participate directly in the formation of the wrist-joint. The radius is less in length and size than the ulna; its superior extremity is small, movable, and enters but slightly into the formation of the elbow-joint. The lower end is large and expanded, and forms the chief part of the wrist-joint.

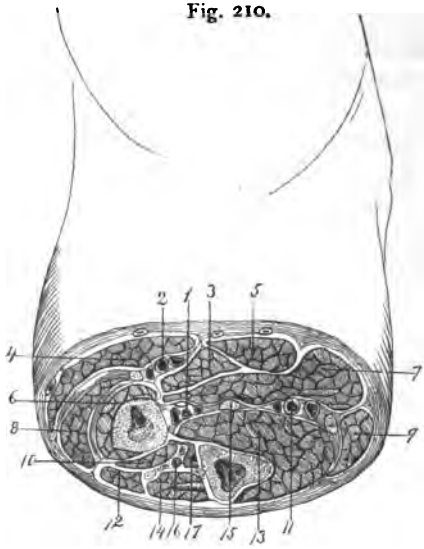
Ligaments.—The radius and ulna are united by two ligaments, the oblique and the interosseous membrane. The former extends from the base of the coronoid process of the ulna, to a point on the radius just below the bicipital tuberosity. The latter, beginning about an inch below the tuberosity, extends between the bones to their lower extremities.

Muscles.—The muscles, which are placed on the anterior, radial, and posterior surfaces of the forearm, are twenty in number, and are classified as flexors, pronators, supinators, and extensors. In the upper and middle portions of the forearm the fleshy bellies of these muscles are placed, while in the lower part they terminate in tendons.

Bloodvessels.—The structures of the forearm are supplied

by the radial, interosseous, and ulnar arteries, with their branches, placed on the outer, middle, and inner surfaces. Numerous large veins ramify in the superficial fascia on the anterior, lateral, and posterior surfaces.

Fig. 210.



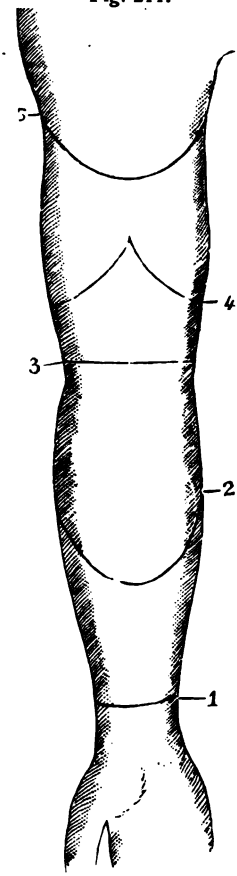
Section through the Middle of the Right Forearm, showing structure.

1. Anterior interosseous vessels and nerves.
2. Radial vessels and nerves.
3. Pronator radii teres muscle.
4. Supinator longus muscle.
5. Flexor carpi radialis muscle.
6. Supinator brevis muscle.
7. Flexor sublimis digitorum muscle.
8. Extensor carpi radialis longior and brevior muscles.
9. Flexor carpi ulnaris muscle.
10. Extensor ossis metacarpi pollicis muscle.
11. Ulnar vessels and nerve.
12. Extensor communis digitorum muscle.
13. Flexor profundus digitorum muscle.
14. Extensor carpi ulnaris muscle.
15. Median nerve.
16. Posterior interosseous vessels and nerve.
17. Extensor secundi internodii pollicis muscle.

Nerves.—The median, ulnar, radial, and interosseous nerves, and their branches, are distributed to the forearm (Fig. 210).

Amputation of the forearm may be performed at any point in the upper, middle, or lower third. The rule of saving as much of the limb as possible should be the guide in operations upon this part.

Fig. 211.



The circular, flap, or rectangular flap method may be employed. In the lower part, the circular or modified circular method is best adapted, owing to the absence, to any great extent, of muscular structures.

In sawing the bones of the forearm, the saw should be applied so as to divide the smaller and most movable bone first. Section of the bones can be facilitated by pressing the thumb between the bones, so as to maintain them in position.

In the lower third. By the circular method.

Operation.—The forearm being held in a position midway between pronation and supination, and the skin retracted, a circular incision is carried around the limb, dividing the skin and superficial fascia (Fig. 211, 1). The cuff of skin and fascia

is dissected up, forming a flap equal in length to one-fourth of the circumference of the limb at the point of section of the bones, and, if necessary, slit up, in order to turn it back. The cuff being held back, a second circular incision is carried around the limb, dividing the muscular structures to the bone. The muscles, with the periosteum, are dissected up to a slight extent, and the interosseous membrane divided. A three-tailed retractor, the middle tail passing through the opening in the interosseous membrane, is applied, so as to thoroughly retract and protect the soft structures, and the saw applied to the bones so as to divide the ulna first. The radial, ulnar, and interosseous arteries will require ligation. The tendons should be retrenched, and the flap united in a transverse direction.

In the lower third. By the rectangular flap method.— The forearm being held in a prone position, incisions dividing the structures to the bone are made on either side, beginning at the point of section of the bones and carried down so as to form a flap equal in length to one-half or one-third the circumference of the limb. These incisions are joined at their points of termination by a transverse incision across the posterior surface of the limb, and the flap is dissected up. The short flap, measuring one-fourth the length of the long flap, is formed by making an incision across the anterior surface of the limb. This flap is dissected up, the interosseous membrane divided, and the bones sawn through. The vessels are ligated and the long flap is drawn over the ends of the bones and approximated to the short flap by sutures.

In the lower third. By the modified circular method.— This method of amputation may be employed in the lower third of the forearm, the skin and superficial fascia being

divided by incisions from without inward so as to form antero-posterior flaps. These are dissected up and the remaining structures are divided by a circular sweep of the knife. The bones are sawn through and the operation completed as in the flap method.

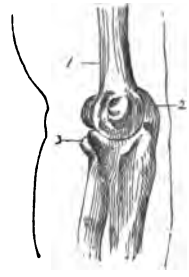
In the middle third. By the single flap method —In this operation the flap is made, by transfixion, from the structures on the anterior surface of the forearm of sufficient length to cover the ends of the bones. The structures on the posterior surface are divided by a slightly convex incision. The remaining steps of the operation are performed as in the circular method, and the anterior flap is drawn over the ends of the bones and united to the posterior flap by suture.

In the middle or upper third. By the double flap method. —The arm being placed midway between supination and pronation, the point of the amputating knife is entered close to the inner edge of the radius and brought out below at the inner edge of the ulna (Fig. 211, 2). Carrying it downward in close contact with the bones to the extent of half an inch, it is brought obliquely outward, forming a semicircular flap. Re-entering it at the same point as before, a similar flap is made on the outside. The flaps being turned back, a circular sweep is made with the knife around the bones, dividing the remaining structures with the periosteum. The periosteum is dissected up to a slight extent, the interosseous membrane divided, and the retractor applied. The bones are sawn through, the arteries ligated, and the flaps approximated by suture.

Amputation at the Elbow-joint. SURGICAL ANATOMY.—The elbow is a true ginglymoid or hinge-joint, uniting the humerus with the radius and ulna.

Bones.—The bones entering into the formation of the joint are the humerus above, and the radius and ulna below. The trochlear surface of the humerus is received in the greater sigmoid cavity of the ulnar, whilst the radial head articulates with the cup shaped depression on the head of the radius (Fig. 212).

Fig. 212.



1. Humerus.
2. Olecranon process of ulna.
3. Head of radius.

Ligaments.—The ligaments of the joints are the anterior, posterior, internal, and external. Together they form a capsular ligament which completely incloses the joint.

Muscles.—The muscles in relation with the joints are, in front, the brachialis anticus; behind, the triceps and anconeus; internally, the common tendon of origin of the flexor muscles of the forearm, and flexor carpi ulnaris; externally, the common tendon of origin of the extensors of the forearm, and the supinator brevis.

Bloodvessels.—Branches of the brachial and anastomosing branches of the brachial with the radial and ulnar arteries, form a network of vessels around the joint.

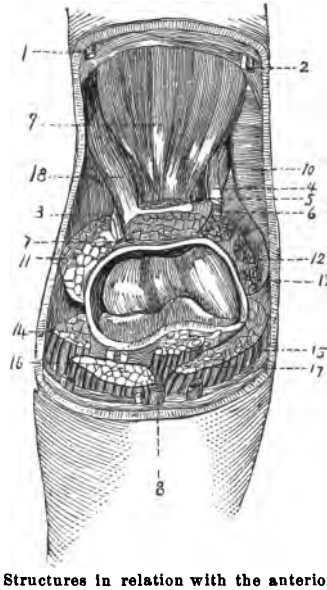
Nerves.—Branches of the ulnar and musculo cutaneous nerves supply the joint (Fig. 213).

Line of the articulation.—The line of articulation is irregular, being transverse between the radius and humerus, and oblique, from without inward, between the ulna and humerus. The condyles of the humerus are marked prominences, which may be taken as guides to the joint. The external, which is the smaller, is *a quarter* of an inch,

and the internal, larger and more prominent, *three-quarters* of an inch above the line of the articulation. The posi-

Fig. 213.

1. Cephalic vein
2. Basalic vein and internal cutaneous nerve.
3. Musculo-spiral nerve.
4. Median nerve.
5. Brachial artery and venæ comites.
6. Anastomotica magna artery.
7. Radial recurrent artery.
8. Median vein.
9. Biceps muscle.
10. Triceps muscle.
11. Supinator longus and extensor carpi radialis longior muscles.
12. Origin of flexor and pronator muscles.
13. Capsule of joint.
14. Extensor carpi radialis longior muscle.
15. Pronator radii teres mu cle.
16. Supinator longus muscle.
17. Tendon of the biceps muscle, beneath which is the brachialis anticus muscle.



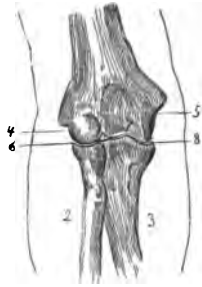
Structures in relation with the anterior aspect of the Elbow-joint.

tions of the condyles, and their relations to the line of articulation, should be always borne in mind in amputation through the joint (Fig. 214).

OPERATION: *By the circular method.*—The arm being held in the position of supination, a circular incision is carried around it three inches below the line of the articulation, dividing skin and superficial fascia. The cuff of skin and fascia is dissected up to the joint and turned back,

and a second incision is made, dividing the muscles to the joint (Fig. 215). The ligaments are divided and disarticulation completed by severing the attachment of the tendon of the triceps muscle to the olecranon process, or sawing through the process. The brachial artery, and possibly some articular branches, require ligation. The edges of the flap are united in the transverse direction.

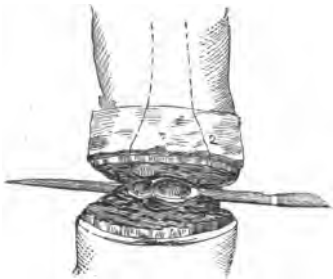
Fig. 214.



1. Humerus.
2. Radius.
3. Ulna.
4. External condyle, or epicondyle.
5. Internal condyle, or epitrochlea.
6, 7, 8. Interarticular line.

By the single flap method. — The forearm being in a position of supination and slightly flexed, the operator, standing on the inner side of the limb, raises the tissues in front of the joint and enters the amputating knife about an inch below the internal condyle (Fig. 216). Carrying it obliquely across the limb in close contact with the bones of the forearm, the point is brought out a half of an inch below the external condyle. Cutting downward in the direction in which the knife is placed, a flap three inches

Fig. 215.



in length is formed. The flap being retracted firmly, a slightly curved incision is made on the posterior aspect extending from the external to the internal angle of the first incision, opening the joint (Fig. 217). The anterior

Fig. 216.

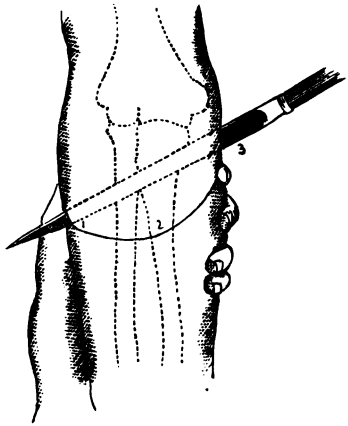
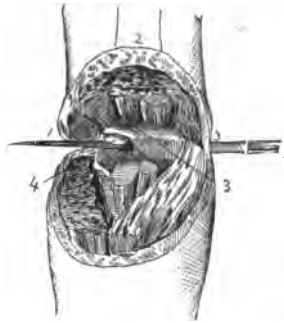


Fig. 217.



and lateral ligaments are now divided, and the insertion of the tendon of the triceps muscle severed or the olecranon process sawn through. The arteries are ligated and the anterior flap is drawn over the surface of the bone and secured to the posterior by sutures.

Amputation of the Arm. SURGICAL ANATOMY.—The arm is that part of the upper extremity which is embraced between the shoulder and elbow. It is cylindrical in form, flattened on the sides, and convex in front and behind.

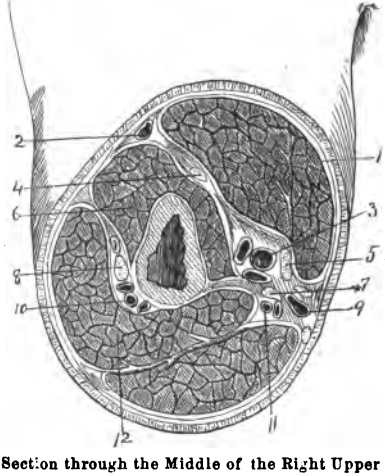
Bone.—The bone of the arm is the humerus, the longest and largest bone of the upper extremity.

Muscles.—The muscles on the anterior surface of the arm are the coraco-brachialis, biceps and brachialis anticus. On the posterior surfaces, the triceps and subanconeus.

Bloodvessels.—The brachial artery, passing down on the inner side, supplies with its branches the structures of the arm.

Nerves.—The musculo-cutaneous, musculo-spiral, and internal cutaneous are the principal nerves distributed to the arm. The median and ulnar nerves, large trunks, pass down on the inner side, but give off no branches to the arm (Fig. 218).

Fig. 218.



Section through the Middle of the Right Upper Arm, showing structure.

Amputation of the arm may be performed at any point and by either the circular, flap, rectangular flap, or oval methods.

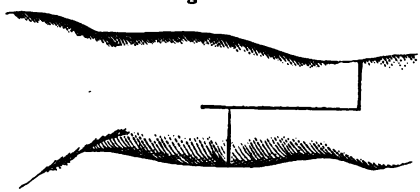
1. Biceps muscle.
2. Cephalic vein.
3. Brachial vessels.
4. Musculo-cutaneous nerve
5. Median nerve.
6. Brachialis anticus muscle.
7. Ulnar nerve.
8. Musculo-spiral nerve.
9. Basilic vein, with internal cutaneous nerves.
10. Superior profunda vessels.
11. Inferior profunda vessels.
12. Triceps muscle, with fibrous intersection.

OPERATION: *In the lower or middle third. By the circular method.*—The arm being held away from the body, a circular incision is carried about it, dividing the skin and superficial fascia (Fig. 211, 3); the cuff of skin and fascia is dissected up to the extent of an inch or two inches according to the size of the limb, and turned back; a second incision is made at the margin of the retracted flap, dividing all of the structures to the bone (Fig. 219). The periosteum, with the muscles, is dissected up, the retractor applied, and the bone sawn through. The brachial artery, with the profunda branches, will require ligation. The edges of the flap are united by sutures in the transverse direction.

Fig. 219.

In the lower third. By the rectangular flap method.—In amputation by this method the short flap, including

Fig. 220.



the brachial artery, is placed on the posterior surface of the arm. In making the longitudinal incisions, therefore, it is important to remember to place the one on the inner side above the line of the brachial artery (Fig. 220). The remaining steps of the operation are the same as in the forearm (p. 260).

In the upper, middle, or lower third. By the single flap method. — Amputation by this method may be performed at any point, the flap being taken from the anterior, posterior, or lateral surfaces. The flap is formed by transfixion, being made of sufficient length to cover the end of the bone, while the short flap is made from without inward by carrying the knife directly down to the bone. The operation is completed as in the thigh (p. 261).

In the upper, middle, or lower third. By the double flap method. — In this operation the flaps are of equal length and may be made from the anterior and posterior, or from the lateral surfaces.

OPERATION. — The arm being at right angles with the body, the tissues are grasped, elevated from the bone, and transfixion is made. Carrying the knife downward in close contact with the bone to a distance of two to two and one-half inches, and cutting obliquely outward, the flap is formed (Fig. 211, 5). Re-entering the knife at the same point, a second flap is made in a similar manner. The retractor is applied and a circular sweep is made with the knife around the bone, dividing the periosteum and the remaining structures. The periosteum is dissected up, the bone sawn through, the vessels ligated, and the flaps approximated by sutures.

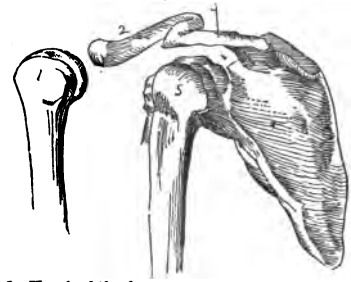
Amputation at the Shoulder-joint. SURGICAL ANATOMY. — The shoulder-joint is an enarthrodial or ball-and-socket joint, connecting the upper extremity to the shoulder.

Bones. — The bones which form the shoulder-joint are the scapula and the humerus, the globular head of the humerus being received into the shallow glenoid cavity on the head of the scapula (Fig. 221).

Ligaments.—The ligaments of the shoulder-joint are the capsular, coraco-humeral, and glenoid.

The *capsular* is a large, loose ligament which is attached above to the circumference of the glenoid cavity, and below to the anatomical neck of the humerus, completely inclosing the joint. The *coraco-humeral* is an accessory ligament which strengthens the upper and inner part of the capsular. The *glenoid* is a fibrous band covering the glenoid cavity, which serves to deepen it, and is continuous with the long tendon of the biceps muscle.

Fig. 221.



1. Head of the humerus.
2. Clavicle.
3. Acromion process.
4. Infra-spinous fossa.
5. Head of humerus connected to glenoid cavity of scapula by capsular ligament.

Muscles.—The muscles in relation with the joint are, above, the supra-spinatus; below, the long head of the triceps: internally, the subscapularis; externally, the infra-spinatus and teres minor: within, the long tendon of the biceps. The deltoid covers the articulation on the outer side, in front, and behind.

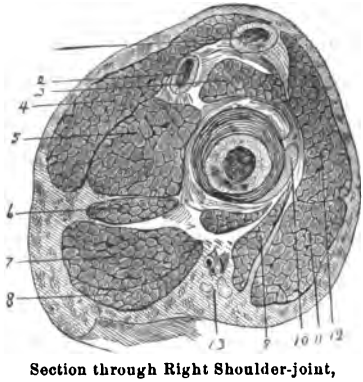
Bloodvessels.—Branches of the anterior and posterior circumflex and supra-scapular arteries supply the joint. The axillary is not in intimate relation with the articulation.

Nerves.—Branches of the circumflex and supra-scapular are distributed to the joint (Fig. 222).

Guides to the articulation.—The acromion process forms a prominent projection above the joint which can be easily

recognized. It is placed nearly half of an inch above the glenoid cavity and projects an inch beyond it. The cora-

Fig. 222.



Section through Right Shoulder-joint, showing structure.

1. Clavicle.
2. Acromion process.
3. Supraspinatus muscle.
4. Trapezius muscle.
5. Infra-spinatus muscle.
6. Teres minor muscle.
7. Teres major muscle.
8. Latissimus dorsi muscle.
9. Coracobrachialis and short head of the biceps muscle.
10. Tendon of the subscapularis muscle, blended with the capsular ligament.
11. Pectoralis major muscle.
12. Deltoid muscle.
13. Axillary vessels and nerves.

coid process is situated within and lower down, and more nearly in contact with the articulation.

Amputation at the shoulder-joint may be performed by either the oval, single, or double flap methods. The subclavian artery should be compressed upon the first rib with the thumb or a padded key.

By the oval method. (Larrey's operation.)

Operation.—Elevating the shoulder of the patient and projecting it beyond the edge of the table, a vertical incision three inches in length, beginning at the apex of the acromion process, is carried downward in the long axis of the arm, dividing the tissues to the bone. From the centre of this incision two oblique incisions are made, one on the anterior and the other on the posterior surface of the arm, extending respectively to the anterior and posterior borders

of the axilla (Fig. 223). The flaps thus formed are dissected up so as to uncover the joint. The arm is now rotated outward, and the insertion of the subscapular muscle into the lesser tuberosity divided. The capsular ligament and the long tendon of the biceps muscle are next divided and the arm is rotated inward in order to separate

Fig. 223.

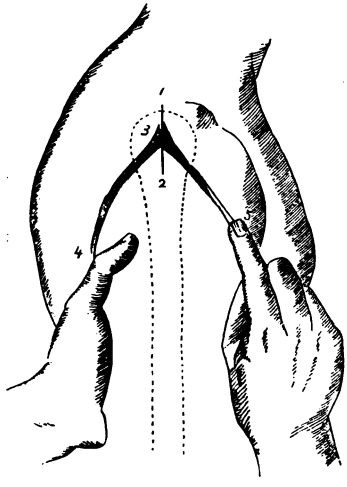
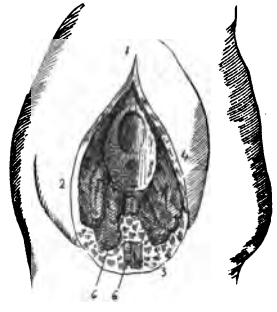


Fig. 224.



1, 2, 3, 4. Wound after Larrey's operation.
5. Glenoid cavity and remains of capsular ligament.
6, 6. Axillary vessels.

the insertions of the supra-spinatus, infra-spinatus, and teres minor muscles into the greater tuberosity. Disarticulation is completed by dividing the remaining portions of the capsular ligament, and the amputating knife is placed behind the bone and the two oblique incisions are joined by a transverse incision, which divides the structures containing the axillary artery (Fig. 224). The artery should be seized as soon as divided, and ligated. The anterior and

posterior circumflex arteries, with, possibly, other articular branches, will require ligation. The edges of the wound are approximated, so as to form, when union has occurred, a linear cicatrix.

By the single flap method. (Dupuytren's operation.)—In this operation the flap, which is formed from the deltoid muscle, may be made either by transfixion or by cutting from without inward. In the *former*, the knife is entered about an inch in front of the acromion process, carried directly across the joint, and brought out at the posterior fold of the axilla. It is then carried downward in close contact with the bone, and a broad flap of sufficient length (three to four inches) is made. This flap is raised, and disarticulation effected by dividing the ligamentous and muscular structures attached to the head of the bone by a semicircular incision, the head being drawn away from the glenoid cavity. The knife is now passed behind the bone and carried to the lower margins of the first incision, and the intervening tissues are divided on a level with the inferior attachments of the pectoralis major and latissimus dorsi muscles. In the *latter*, the incision is commenced near the anterior border of the deltoid muscle on a level with the articulation, descending in a curved direction to within two-thirds of an inch of the insertion of the muscle and, ascending on the posterior surface, terminates at the same level as the point of origin (Fig. 225). This flap is dissected up, disarticulation effected, and the amputating knife passed behind the bone, and the inferior incision made from within outward. The arteries are ligated and the incisions united by sutures.

By the double flap method. (Lisfranc's operation.)—In this method the amputating knife is entered at the outer

side of the posterior border of the axilla, in front of the tendons of the latissimus dorsi and teres major muscles;

Fig. 225.

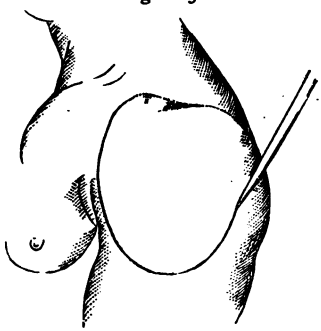
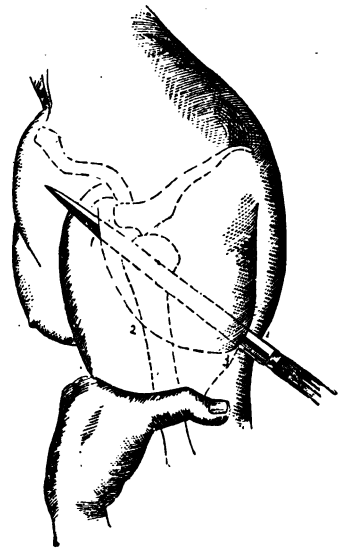


Fig. 226.

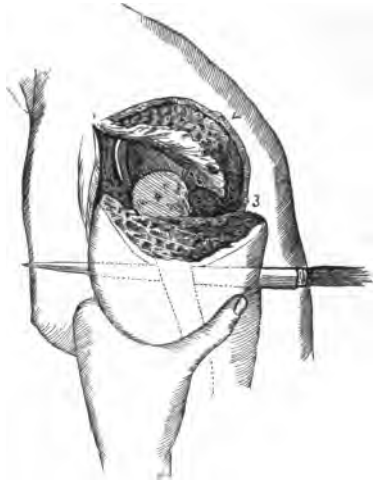


passing obliquely upward in close contact with the joint, the handle is elevated and the point is brought out in front and below the clavicle in the triangular space formed by the acromion and coracoid processes and the clavicle (Fig. 226). The arm being drawn from the body, and the deltoid muscle raised from the bone, the knife is carried downward in close contact with the bone, forming a posterior semicircular flap three inches in length. Disarticulation is effected, and the knife passed behind the bone, and the anterior flap, of the same length as the posterior, is

made by carrying it downward and forward, dividing the structures which contain the axillary artery (Fig. 227). The arteries are ligated and the flaps approximated by sutures.

In amputations of the upper extremity the arterial circulation may be controlled by digital compression of the

Fig. 227.



brachial artery in the middle of the arm, or by the application of the tourniquet over a compress at the same part. Esmarch's bandage may be used as in the lower extremity.

In amputation at the shoulder-joint, the subclavian artery is to be compressed against the first rib by the handle of a key well padded.

INDEX.